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CAMBRIDGE, MASSACHUSETTS 02138

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SATELLITE ORBITAL DATA

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## NOTE

It is in the nature of frequently used computer programs that from time to time they undergo modifications as dictated by the experience of people who use them. Thus our Differential Orbit Improvement Program, being in use since the end of 1958, has been changed on several occasions. In the past we did not give notice of any of these changes, because they affected merely the internal structure and the capabilities of the program. Some recent modifications, however, should be pointed out because they alter the definition of the mean orbital elements.

1. As before, the semimajor axis  $a$  of an orbit is being computed from the mean motion  $n$  of the satellite according to the formula

$$a = \sqrt[3]{\frac{CM}{n^2}} \left\{ 1 - \frac{\frac{J_2 a_E^2}{2}}{2p^2} \sqrt{1 - e^2} \left( 1 - \frac{3}{2} \sin^2 I \right) \right\}$$

(Y. Kozai, Astron. Journ., vol. 64, pp. 367-377; in his equation (14) we put  $A_2 = \frac{3}{2} J_2 a_E^2$ ). In the old program, the mean motion in turn was defined as the time derivative of the mean anomaly  $M$ . Therefore in cases where in addition to a polynomial part the mean anomaly also had a trigonometric part, the program produced small but unwanted, long-periodic variations in the semimajor axis. In the new program the mean motion is defined as the time derivative of the mean anomaly's polynomial part only.

2. The old program provided internally only for those first-order short-periodic perturbations that are caused by the second zonal harmonic ( $J_2$ -term) of the geopotential. The new program has the optional capability to account for lunar perturbations with periods of approximately two weeks. Their analytical expressions are quite complicated and will not be given here. As a rule, we use this feature of the program only in connection with orbits that are computed from precisely reduced Baker-Nunn observations. In our future publications of satellite orbital data we will always mention if lunar perturbations were included in the computations.

A detailed write-up of the new Differential Orbit Improvement Program, henceforth called DOI-3, will be given shortly by Mr. Edward M. Gaposchkin.

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## ORBITAL INFORMATION<sup>1</sup>

The orbital elements have been derived by the indicated staff members of the Satellite Tracking Program, Smithsonian Astrophysical Observatory, employing the SAO Differential Orbit Improvement Program (DOI).

Field-reduced photographs from SAO Baker-Nunn cameras comprise the majority of observations used in computing these orbital data. SAO Moonwatch teams, the NASA Minitrack network, foreign observatories, miscellaneous U.S. and foreign observers, and various radar installations also contribute valuable observations.

As opposed to osculating elements, the elements presented here are mean elements in the sense that the effects of the short-period perturbations due to the earth's oblateness have been eliminated.

SAO mean elements have been derived from observations covering several days and are given in the form of a table. The successive sets of elements are essentially independent of each other. They are dependent, however, in the sense that high-order coefficients in the secular and the long-periodic terms are generally considered as known and as constant for periods of several weeks or months, as dictated by convenience.

The times of epoch in the mean elements are reckoned in Julian Days, but for the sake of convenience the number 2400000.5 has been subtracted to provide an abbreviated notation which we call "Modified Julian Days," or "MJD."

The units of the orbital elements are degrees for angular quantities, megameters ( $Mm = 10^6$  meters) for linear quantities, and revolutions for the mean anomaly  $M$  and its derivatives.

The tabulated values of the SAO mean elements give the values of argument of perigee  $\omega$ , right ascension of the ascending node  $\Omega$ , inclination  $i$ , eccentricity  $e$ , and mean anomaly  $M$  as functions of time  $t = T - T_0$  (where  $T_0$  is the reference epoch) expressed in days. The single digit placed at the right of each value represents the standard error for that element and refers to the last digit given.

The same tabulation also gives the mean (anomalistic) motion  $n$ , the orbital acceleration  $n'/2$  or  $n'$  ( $dn/dt$ ), and the semimajor axis  $a$  or the geocentric distance of perigee  $q$  (in megameters). Of the last three columns, the one headed  $N$  indicates the number of observations used for the computation of a set of elements; the one headed  $D$ , the number of days used; and the one headed  $\sigma$ , the standard error of the representation of the observations relative to their assumed accuracy.

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<sup>1</sup>This work was supported in part by grant NsG 87-60 from the National Aeronautics and Space Administration.

SAO smoothed elements have been derived from observations covering about two weeks or more. They are given as functions of time and generally include both secular and periodic terms. The general expression for any element  $E$  is

$$E = E_0 + E_1 t + E_2 t^2 + \dots + \sum A_i \sin (B_i + C_i t) ,$$

where  $t = T - T_0$  is again expressed in days. The presence of a standard error associated with a particular coefficient indicates that this quantity was determined by the process of differential orbit improvement; the absence of a standard error means that the quantity was taken from some other source.

In our computer program, the inclination and the argument of perigee are referred to the true equator of date; the right ascension of the ascending node, however, is reckoned from the mean equinox of 1950.0 along the corresponding mean equator to the intersection with the moving true equator of date, and then along the true equator of date. To transform from right ascension of the node as determined by the  $D\phi I$  to right ascension of the node referred to the mean equinox of date, one uses

$$\Omega^\circ = \Omega^\circ (D\phi I) + 3^\circ.508 \times 10^{-5} (MJD - 33281),$$

where MJD stands for the Modified Julian Day of the date.

The mean (anomalistic) motion  $n$  can be obtained from the smoothed elements by differentiating the expression for  $M$ , and the orbital acceleration  $n'$  can be obtained by twice differentiating the same expression for  $M$ .

The sun-perigee data are related to the perturbing effects of atmospheric drag. From left to right are the Modified Julian Day (MJD); the perigee height  $Z$  (in kilometers) above the International Ellipsoid of Reference; the geocentric latitude of the perigee ( $\psi$ ); the angular geocentric distance ( $\psi$ ) from the perigee of the sun; and the difference in right ascension (D.R.A.) between the perigee and the sun; all these angles are expressed in degrees. In the last column we give the rate of change of the period ( $\dot{P}$ ) expressed in days per day.

Satellite 1958 Alpha (Explorer 1)

Eleanor Ryan

## I. SAO smoothed elements

The following elements are based on 173 observations and are valid for the period July 1 through July 15, 1963.

$$T_0 = 38218.0 \text{ MJD}$$

$$\omega = (232^\circ 30 \pm 1) + (7^\circ 624 \pm 3)t + ^\circ 000307t^2 + ^\circ 3144 \cos \omega$$

$$\Omega = (224^\circ 272 \pm 2) - (5^\circ 0973 \pm 5)t - ^\circ 73 \times 10^{-4}t^2 + ^\circ 0031 \cos \omega$$

$$i = (33^\circ 2012 \pm 6) + ^\circ 000154t - ^\circ 21 \times 10^{-5}t^2 - ^\circ 0039 \sin \omega$$

$$e = (.088833 \pm 9) + .127 \times 10^{-5}t - .50 \times 10^{-7}t^2 + .0004980 \sin \omega$$

$$M = (.97772 \pm 5) + (13.69975 \pm 1)t + (.830 \pm 3) \times 10^{-4}t^2$$

$$- (.126 \pm 3) \times 10^{-5}t^3 - (.37 \pm 7) \times 10^{-7}t^4 - .0008998 \cos \omega$$

Standard error of one observation:  $\sigma = \pm 1^\circ 43$ .

The following elements are based on 189 observations and are valid for the period July 15 through August 1, 1963.

$$T_0 = 38234.0 \text{ MJD}$$

$$\omega = (354^\circ 164 \pm 9) + (7^\circ 620 \pm 2)t + ^\circ 000307t^2 + ^\circ 3144 \cos \omega$$

$$\Omega = (142^\circ 690 \pm 2) - (5^\circ 1003 \pm 4)t - ^\circ 93 \times 10^{-4}t^2 + ^\circ 0031 \cos \omega$$

$$i = (33^\circ 2021 \pm 6) + ^\circ 87 \times 10^{-4}t - ^\circ 21 \times 10^{-5}t^2 - ^\circ 0039 \sin \omega$$

$$e = (.088635 \pm 6) - .33 \times 10^{-6}t - .50 \times 10^{-7}t^2 + .0004980 \sin \omega$$

$$M = (.19410 \pm 3) + (13.702605 \pm 5)t + (.0001234 \pm 2)t^2$$

$$+ (.68 \pm 1) \times 10^{-6}t^3 - (.64 \pm 3) \times 10^{-7}t^4 - .0008998 \cos \omega$$

Standard error of one observation:  $\sigma = \pm 1^\circ 63$ .

The following elements are based on 68 observations and are valid for the period August 1 through August 16, 1963.

$$T_0 = 38250.0 \text{ MJD}$$

$$\omega = (116^\circ.04 \pm 1) + (7^\circ.624 \pm 1)t + .000307t^2 + .3144 \cos \omega$$

$$\Omega = (61^\circ.060 \pm 2) - (5^\circ.1036 \pm 5)t - .93 \times 10^{-4}t^2 + .0031 \cos \omega$$

$$i = (33^\circ.204 \pm 1) + .20 \times 10^{-4}t - .21 \times 10^{-5}t^2 - .0039 \sin \omega$$

$$e = (.08853 \pm 1) - .193 \times 10^{-5}t - .50 \times 10^{-7}t^2 + .0004980 \sin \omega$$

$$M = (.46898 \pm 3) + (13.706726 \pm 4)t + (.0001140 \pm 4)t^2$$

$$- (.124 \pm 3) \times 10^{-5}t^3 + (.47 \pm 62) \times 10^{-8}t^4 - .0008998 \cos \omega$$

Standard error of one observation:  $\sigma = \pm 1^\circ.30$ .

The following elements are based on 122 observations and are valid for the period August 16 through September 1, 1963.

$$T_0 = 38266.0 \text{ MJD}$$

$$\omega = (237^\circ.996 \pm 5) + (7^\circ.632 \pm 1)t + .000307t^2 + .3144 \cos \omega$$

$$\Omega = (339^\circ.393 \pm 3) - (5^\circ.1066 \pm 5)t - .93 \times 10^{-4}t^2 + .0031 \cos \omega$$

$$i = (33^\circ.2046 \pm 8) - .47 \times 10^{-4}t - .21 \times 10^{-5}t^2 - .0039 \sin \omega$$

$$e = (.08837 \pm 2) - .353 \times 10^{-5}t - .50 \times 10^{-7}t^2 + .0004980 \sin \omega$$

$$M = (.80625 \pm 1) + (13.710742 \pm 3)t + (.0001347 \pm 3)t^2$$

$$- (.164 \pm 3) \times 10^{-5}t^3 - (.19 \pm 5) \times 10^{-7}t^4 - .0008998 \cos \omega$$

Standard error of one observation:  $\sigma = \pm 1^\circ.53$ .

The following elements are based on 74 observations and are valid for the period September 1 through September 15, 1963.

$$T_0 = 38280.0 \text{ MJD}$$

$$\omega = (344^\circ 785 \pm 9) + (7^\circ 639 \pm 2)t + .000307t^2 + .3144 \cos \omega$$

$$\Omega = (267^\circ 886 \pm 3) - (5^\circ 1088 \pm 7)t - .93 \times 10^{-4}t^2 + .0031 \cos \omega$$

$$i = (33^\circ 2048 \pm 8) - .000106t - .21 \times 10^{-5}t^2 - .0039 \sin \omega$$

$$e = (.08820 \pm 2) - .493 \times 10^{-5}t - .50 \times 10^{-7}t^2 + .0004980 \sin \omega$$

$$M = (.77914 \pm 3) + (13.713753 \pm 8)t + (.0001116 \pm 4)t^2$$

$$+ (.171 \pm 3) \times 10^{-5}t^3 + (.23 \pm 9) \times 10^{-7}t^4 - .0008998 \cos \omega$$

Standard error of one observation:  $\sigma = \pm 1^\circ 13$ .

The following elements are based on 64 observations and are valid for the period September 15 through October 1, 1963.

$$T_0 = 38296.0 \text{ MJD}$$

$$\omega = (106^\circ 94 \pm 2) + (7^\circ 623 \pm 2)t + .000307t^2 + .3144 \cos \omega$$

$$\Omega = (186^\circ 114 \pm 5) - (5^\circ 112 \pm 1)t - .93 \times 10^{-4}t^2 + .0031 \cos \omega$$

$$i = (33^\circ 200 \pm 2) - .000173t - .21 \times 10^{-5}t^2 - .0039 \sin \omega$$

$$e = (.08802 \pm 2) - .653 \times 10^{-5}t - .50 \times 10^{-7}t^2 + .0004980 \sin \omega$$

$$M = (.23729 \pm 4) + (13.719022 \pm 8)t + (.0001820 \pm 6)t^2$$

$$- (.36 \pm 2) \times 10^{-5}t^3 - (.23 \pm 1) \times 10^{-6}t^4 + (.11 \pm 2) \times 10^{-7}t^5$$

$$- .0008998 \cos \omega$$

Standard error of one observation:  $\sigma = \pm 2^\circ 98$ .

## II. SAO mean elements -- Satellite 1958 Alpha

2 July - 28 September 19

(MJD)	$\omega$	$\Omega$	$i$	$e$	$M$	$n$	$n'/2$	$q$	$N$	$D$	$\sigma$
38212.0	186.28 1	254.855 3	33.2025 8	.088773 8	*78324 4	13.698755 2	*901E-4 4	6.721733	87	8	.54
38216.0	216.79 2	234.468 3	33.2039 8	.08853 1	.57929 6	13.699468 2	*924E-4 4	6.723297	94	8	.57
38220.0	247.43 2	214.075 2	33.2047 7	.08833 1	.37790 6	13.700141 2	*711E-4 4	6.724518	98	8	.47
38224.0	278.01 2	193.683 2	33.2045 7	.08827 1	.17900 6	13.700648 2	*645E-4 4	6.724849	96	8	.49
38228.0	308.66 1	173.292 3	33.2043 8	.08832 1	.98206 4	13.701288 2	*987E-4 4	6.724241	86	8	.54
38232.0	339.206 9	152.892 2	33.2035 6	.088483 5	.78859 3	13.702141 2	*1128E-3 3	6.722760	96	8	.44
38236.0	9.67 1	132.489 2	33.2009 6	.088714 6	.59903 3	13.703140 2	*1281E-3 4	6.720731	91	8	.50
38240.0	4C.11 1	112.088 3	33.1994 9	.08891 1	.41362 4	13.704105 2	*1264E-3 4	6.718973	77	8	.63
38244.0	7C.42 1	91.680 3	33.199 1	.08902 1	.23266 4	13.705229 3	*1396E-3 8	6.717769	47	8	.50
38248.0	10C.73 1	71.272 5	33.199 2	.08905 2	.05615 4	13.706263 3	*1214E-3 5	6.717239	25	8	.44
38252.0	131.07 1	50.853 4	33.202 3	.08891 2	.88350 4	13.707186 3	*101E-3 3	6.717961	24	8	.39
38256.0	161.45 1	30.441 3	33.201 2	.08854 3	.71413 3	13.707968 4	*1023E-3 8	6.720413	30	8	.59
38260.0	191.942 8	10.025 4	33.205 2	.08824 2	.54782 2	13.708932 3	*1460E-3 6	6.722372	63	8	.68
38264.0	222.523 4	349.604 2	33.2080 6	.08801 1	.38588 1	13.710210 2	*1491E-3 3	6.723643	65	8	.42
38268.0	253.176 5	329.179 2	33.2086 6	.08787 2	.22851 1	13.711259 2	*1219E-3 4	6.724301	63	8	.39
38272.0	283.859 9	308.759 5	33.2086 7	.08780 2	.07498 3	13.712182 3	*1059E-3 5	6.724514	54	8	.41
38276.0	314.56 5	288.324 5	33.2067 8	.08794 6	.9248 2	13.712948 3	*949E-4 4	6.723222	48	8	.43
38280.0	345.C90 6	267.890 2	33.204 1	.08806 2	.77826 2	13.713756 2	*1127E-3 5	6.722114	41	8	.43
38284.0	15.654 6	247.454 2	33.203 1	.08830 2	.63517 2	13.714727 3	*1354E-3 7	6.720017	41	8	.51
38288.0	46.113 9	227.007 4	33.199 1	.08849 2	.49683 2	13.716016 2	*1769E-3 9	6.718186	31	8	.63
38292.0	76.49 1	206.562 6	33.197 2	.08859 2	.36426 2	13.717394 2	*158E-3 2	6.716984	35	8	.84
38296.0	106.81 1	186.121 6	33.198 2	.08849 2	.23759 3	13.718991 3	*187E-3 1	6.717233	41	8	1.00
38300.0	137.23 1	165.663 4	33.198 1	.08834 2	.11662 3	13.720168 2	*1188E-3 6	6.717925	35	8	.69

Table 1

## RELATIVE POSITIONS OF THE SUN AND THE PERIGEE OF SATELLITE 1958 ALPHA

MJD	Z	$\Psi$	$\psi$	D.R.A.	$\dot{P}$
PERIGEE IN SUNLIGHT					
38212.	343.	-3.4	33.0	339.9	-0.960E-06
38216.	347.	-19.1	45.4	342.1	-0.985E-06
38220.	352.	-30.4	53.7	349.2	-0.758E-06
38224.	353.	-32.8	54.7	0.7	-0.687E-06
38228.	350.	-25.3	47.6	10.4	-0.105E-05
38232.	345.	-11.2	34.8	14.7	-0.120E-05
38236.	343.	5.3	21.2	16.0	-0.136E-05
38240.	343.	20.7	17.7	18.8	-0.135E-05
38244.	345.	31.1	27.2	26.2	-0.149E-05
38248.	345.	32.5	37.6	37.8	-0.129E-05
38252.	343.	24.4	44.8	46.9	-0.108E-05
38256.	343.	10.0	49.9	50.9	-0.109E-05
38260.	344.	-6.5	55.7	52.5	-0.155E-05
38264.	348.	-21.7	64.2	55.8	-0.159E-05
38268.	352.	-31.6	74.5	64.3	-0.130E-05
38272.	352.	-32.1	83.6	76.6	-0.113E-05
38276.	348.	-23.0	89.0	85.7	-0.101E-05
38280.	344.	-8.1	90.3	89.5	-0.120E-05
38284.	342.	8.5	90.5	91.2	-0.144E-05
38288.	343.	23.2	93.4	95.0	-0.188E-05
38292.	345.	32.2	100.9	103.9	-0.168E-05
PERIGEE IN EARTH SHADOW					
38296.	345.	31.6	111.8	115.8	-0.199E-05
38300.	343.	21.8	122.1	124.1	-0.126E-05

## I. SAO smoothed elements

The following elements are based on 124 observations and are valid for the period July 1 through August 1, 1963.

$$T_0 = 38226.0 \text{ MJD}$$

$$\omega = (359^\circ 266 \pm 5) + (5^\circ 2926 \pm 6)t + ^\circ 000111t^2 + ^\circ 1523 \cos \omega$$

$$\Omega = (285^\circ 934 \pm 2) - (3^\circ 5203 \pm 2)t + ^\circ 26 \times 10^{-5}t^2 + ^\circ 0077 \cos \omega$$

$$i = (32^\circ 8789 \pm 6) - ^\circ 0069 \sin \omega$$

$$e = (.164261 \pm 4) + .82 \times 10^{-6}t + .000457 \sin \omega$$

$$M = (.75389 \pm 1) + (11.479662 \pm 1)t + (.15 \pm 2) \times 10^{-6}t^2$$

$$+ (.62 \pm 21) \times 10^{-8}t^3 - .000439 \cos \omega$$

Standard error of one observation:  $\sigma = \pm 1^\circ 10$ .

The following elements are based on 137 observations and are valid for the period August 1 through September 1, 1963.

$$T_0 = 38258.0 \text{ MJD}$$

$$\omega = (168^\circ 614 \pm 5) + (5^\circ 2940 \pm 5)t + ^\circ 000111t^2 + ^\circ 1523 \cos \omega$$

$$\Omega = (173^\circ 281 \pm 2) - (3^\circ 5208 \pm 2)t + ^\circ 26 \times 10^{-5}t^2 + ^\circ 0077 \cos \omega$$

$$i = (32^\circ 8775 \pm 6) - ^\circ 0069 \sin \omega$$

$$e = (.164273 \pm 6) + .82 \times 10^{-6}t + .000457 \sin \omega$$

$$M = (.10363 \pm 1) + (11.479693 \pm 1)t + (.36 \pm 2) \times 10^{-6}t^2$$

$$- (.17 \pm 21) \times 10^{-10}t^3 - .000439 \cos \omega$$

Standard error of one observation:  $\sigma = \pm 1^\circ 28$ .

The following elements are based on 86 observations and are valid for the period September 1 through October 1, 1963.

$$T_0 = 38288.0 \text{ MJD}$$

$$\omega = (327^\circ 411 \pm 5) + (5^\circ 2941 \pm 5)t + .000111t^2 + .1523 \cos \omega$$

$$\Omega = (67^\circ 654 \pm 2) - (3^\circ 5214 \pm 3)t + .26 \times 10^{-5} t^2 + .0077 \cos \omega$$

$$i = (32^\circ 8784 \pm 9) - .0069 \sin \omega$$

$$e = (.164289 \pm 8) + .82 \times 10^{-6} t + .000457 \sin \omega$$

$$M = (.49489 \pm 1) + (11.479712 \pm 1)t + (.12 \pm 2) \times 10^{-6} t^2$$

$$+ (.21 \pm 2) \times 10^{-7} t^3 - .000439 \cos \omega$$

Standard error of one observation:  $\sigma = \pm 1.15$ .

$T$ (MJD)	$\omega$	$\Omega$	$i$	$e$	$M$	$n$	$n^{1/2}$	$q$	$N$	$D$	$\sigma$
38214.0	295.81 2	328.190 7	32.888 3	.16387 2	.99784 4	11.479678 2	.50E-6 88	6.939231	17 8	.60	
38218.0	317.04 1	314.107 4	32.886 1	.16393 1	.91627 3	11.479683 1	.39E-6 42	6.938728	21 8	.37	
38222.0	338.232 9	300.024 4	32.882 1	.164061 8	.83485 2	11.4796874 8	.11E-5 4	6.937669	22 8	.34	
38226.0	359.42 1	285.946 5	32.880 1	.164231 9	.75345 3	11.479685 1	.91E-6 56	6.936264	30 8	.49	
38230.0	2C.600 9	271.858 3	32.8773 9	.164416 7	.67208 2	11.4796855 9	.12E-5 4	6.934726	49 8	.46	
38234.0	41.738 9	257.775 4	32.8734 9	.164583 7	.59086 2	11.4796894 8	.10E-5 4	6.933341	52 8	.45	
38238.0	62.85 1	243.698 4	32.871 2	.16469 1	.50969 2	11.4796890 9	.74E-6 43	6.932432	39 8	.54	
38242.0	83.97 1	229.613 3	32.870 2	.16476 1	.42855 2	11.479692 1	.26E-6 48	6.931906	30 8	.53	
38246.0	105.08 1	215.527 3	32.869 2	.16476 1	.34744 4	11.479695 2	.78E-6 56	6.931881	24 8	.55	
38250.0	126.19 1	201.438 5	32.868 2	.16466 1	.26635 3	11.479696 1	.58E-6 52	6.932695	25 8	.40	
38254.0	147.301 9	187.363 4	32.875 2	.164525 9	.18525 2	11.479701 1	.1E-7 42	6.933816	29 8	.38	
38258.0	168.459 9	173.270 4	32.875 1	.164339 9	.10409 2	11.479700 1	.37E-6 49	6.935355	40 8	.49	
38262.0	185.660 8	159.179 4	32.8794 8	.164174 8	.02282 2	11.4797042 9	.96E-6 41	6.936727	44 8	.43	
38266.0	210.855 7	145.102 4	32.8817 7	.16402 1	.94156 2	11.4797073 7	.37E-6 30	6.937977	45 8	.42	
38270.0	232.053 8	131.026 5	32.884 1	.16390 1	.86031 2	11.4797110 8	-.1E-7 38	6.938991	38 8	.47	
38274.0	253.28 1	116.954 7	32.885 2	.16387 2	.77899 2	11.479713 2	.78E-6 59	6.939210	21 8	.49	
38278.0	274.51 1	102.861 8	32.888 3	.16389 2	.69770 3	11.479708 1	-.56E-6 55	6.939064	13 8	.55	
38282.0	295.73 2	88.786 5	32.883 2	.16395 4	.61639 4	11.479707 2	-.52E-6 59	6.938603	15 8	.58	
38286.0	316.97 1	74.713 8	32.886 3	.16412 6	.53508 4	11.479707 2	-.63E-6 85	6.937174	22 8	.49	
38290.0	338.13 1	60.612 6	32.879 2	.16408 2	.45395 3	11.479704 1	.21E-6 58	6.937500	27 8	.47	
38294.0	359.329 8	46.531 3	32.878 1	.16427 1	.37274 2	11.479706 1	.12E-5 5	6.935934	29 8	.38	
38298.0	2C.496 8	32.450 3	32.876 1	.16443 1	.29165 2	11.4797129 7	.65E-6 31	6.934564	34 8	.46	
38302.0	41.62 1	18.369 5	32.875 1	.16460 2	.21069 2	11.4797137 7	-.48E-6 35	6.933227	31 8	.60	

Table 2

## RELATIVE POSITIONS OF THE SUN AND THE PERIGEE OF SATELLITE 1959 ALPHA 1

MJD	Z	$\Phi$	$\Psi$	D. R.A.	$\dot{P}$
PERIGEE IN EARTH SHADOW					
38214.	566.	-29.3	165.8	165.8	-0.759E-08
38218.	563.	-21.7	170.4	169.6	-0.592E-08
38222.	560.	-11.6	166.4	171.0	-0.167E-07
38226.	558.	-0.3	157.0	170.9	0.138E-07
38230.	557.	11.0	146.9	170.8	-0.182E-07
38234.	558.	21.2	138.0	172.0	0.152E-07
38238.	559.	28.9	131.7	175.7	-0.112E-07
38242.	560.	32.7	129.0	182.0	-0.395E-08
38246.	559.	31.6	130.4	189.0	-0.118E-07
38250.	558.	26.0	135.6	194.3	-0.880E-08
38254.	557.	17.1	143.8	197.1	-0.152E-09
38258.	557.	6.2	153.3	197.8	-0.562E-08
38262.	559.	-5.2	160.9	197.9	-0.146E-07
38266.	561.	-16.2	161.2	198.6	-0.562E-08
38270.	565.	-25.4	154.4	201.4	0.152E-09
38274.	567.	-31.3	146.0	206.8	-0.118E-07
38278.	567.	-32.8	139.0	214.2	0.850E-08
38282.	565.	-29.3	134.5	221.0	0.789E-08
38286.	562.	-21.7	132.5	225.4	0.956E-08
38290.	560.	-11.7	132.3	227.2	-0.319E-08
38294.	558.	-0.4	132.5	227.5	-0.182E-07
38298.	557.	11.0	131.4	227.9	-0.986E-08
38302.	558.	21.1	128.4	229.5	0.728E-08

## I. SAO smoothed elements

The following elements are based on 166 observations and are valid for the period July 1 through August 1, 1963.

$$T_0 = 38226.0 \text{ MJD}$$

$$\omega = (119^\circ 684 \pm 6) + (4^\circ 8923 \pm 7)t - .21 \times 10^{-5}t^2 + .1295 \cos \omega$$

$$\Omega = (328^\circ 017 \pm 2) - (3^\circ 2865 \pm 2)t - .38 \times 10^{-5}t^2 + .0090 \cos \omega$$

$$i = (33^\circ 3535 \pm 7) - .000109t - .0077 \sin \omega$$

$$e = (.188457 \pm 9) - .73 \times 10^{-7}t + .000452 \sin \omega$$

$$M = (.79467 \pm 2) + (11.088550 \pm 2)t + (.69 \pm 4) \times 10^{-6}t^2 \\ - (.49 \pm 3) \times 10^{-7}t^3 - .000376 \cos \omega$$

Standard error of one observation:  $\sigma = \pm 1.05$ .

The following elements are based on 247 observations and are valid for the period August 1 through September 1, 1963.

$$T_0 = 38258.0 \text{ MJD}$$

$$\omega = (276^\circ 282 \pm 5) + (4^\circ 8937 \pm 6)t - .21 \times 10^{-5}t^2 + .1295 \cos \omega$$

$$\Omega = (222^\circ 844 \pm 1) - (3^\circ 2869 \pm 2)t - .38 \times 10^{-5}t^2 + .0090 \cos \omega$$

$$i = (33^\circ 3493 \pm 5) - .000109t - .0077 \sin \omega$$

$$e = (.188419 \pm 6) - .73 \times 10^{-7}t + .000452 \sin \omega$$

$$M = (.62882 \pm 2) + (11.088635 \pm 2)t + (.274 \pm 2) \times 10^{-5}t^2 \\ + (.79 \pm 26) \times 10^{-8}t^3 - .000376 \cos \omega$$

Standard error of one observation:  $\sigma = \pm 0.95$ .

The following elements are based on 198 observations and are valid for the period September 1 through October 1, 1963.

$$T_0 = 38268.0 \text{ MJD}$$

$$\omega = (63^\circ 124 \pm 4) + (4^\circ 8946 \pm 6)t - 21 \times 10^{-5} t^2 + 1295 \cos \omega$$

$$\Omega = (124^\circ 241 \pm 2) - (3^\circ 2868 \pm 2)t - 38 \times 10^{-5} t^2 + 0.0090 \cos \omega$$

$$i = (33^\circ 3500 \pm 7) - 0.000109t - 0.0077 \sin \omega$$

$$e = (.188418 \pm 9) + (.78 \pm 10) \times 10^{-5} t + .000452 \sin \omega$$

$$M = (.28994 \pm 1) + (11.088794 \pm 2)t + (.689 \pm 9) \times 10^{-5} t^2 \\ + (.132 \pm 3) \times 10^{-6} t^3 - (.45 \pm 4) \times 10^{-8} t^4 - .000376 \cos \omega$$

Standard error of one observation:  $\sigma = \pm 1.08$ .

## II. SAO mean elements -- Satellite 1959 Eta

4 July - 30 September 1963

T (MJD)	$\omega$	$\Omega$	i	e	M	n	$n'/2$	q	N	D	$\sigma$
38214.0	60.98 8	7.44 2	33.36 2	.1881 6	.73201 8	11.088501 6	.79E-5 48	6.896034	11	6	.75
38218.0	80.56 2	354.306 5	33.343 2	.08634 5	11.088517 4	-.27E-5 23	6.888406	13	6	.37	
38222.0	100.10 1	341.154 5	33.342 2	.46054 4	11.088531 2	.8E-6 17	6.889194	27	6	.36	
38226.0	119.62 1	328.003 4	33.344 1	.79487 4	11.088534 3	.1E-6 18	6.889189	33	6	.40	
38230.0	139.14 2	314.861 4	33.348 2	.14920 5	11.088546 2	.11E-5 13	6.889987	32	6	.46	
38234.0	158.71 1	301.720 3	33.353 1	.50340 4	11.088540 2	-.19E-5 11	6.891498	54	6	.42	
38238.0	178.26 1	288.572 3	33.354 1	.85765 4	11.088533 2	.5E-6 10	6.892655	50	6	.37	
38242.0	197.85 2	275.424 9	33.355 2	.21178 9	11.088533 3	.9E-6 20	6.893392	32	6	.44	
38246.0	217.47 1	262.290 5	33.360 2	.18817 3	.56577 6	11.088563 3	.12E-5 17	6.895193	19	6	.30
38250.0	237.061 9	249.135 3	33.355 1	.92013 3	11.088588 2	.4E-6 14	6.895635	42	6	.34	
38254.0	256.68 1	235.587 1	33.357 1	.18811 2	.27440 4	11.088603 2	.9E-6 12	6.896194	52	6	.39
38258.0	276.302 9	222.845 3	33.357 1	.62875 3	11.088628 2	.36E-5 12	6.896654	62	6	.39	
38262.0	295.934 7	209.701 2	33.3548 9	.98315 2	11.088651 2	.60E-5 10	6.896526	63	6	.33	
38266.0	315.52 1	196.553 3	33.355 1	.18810 1	.33783 4	11.088673 2	.9E-6 10	6.895738	60	6	.35
38270.0	335.13 2	183.409 3	33.348 1	.18818 1	.69250 5	11.088702 2	.17E-5 11	6.895003	49	6	.38
38274.0	354.72 2	170.267 4	33.349 1	.18832 1	.04729 5	11.088712 2	-.6E-6 12	6.893798	31	6	.38
38278.0	14.31 2	157.121 4	33.348 2	.40209 5	11.088721 2	.12E-5 13	6.892455	30	6	.41	
38282.0	33.860 9	143.968 3	33.345 1	.75711 3	11.088735 2	.32E-5 10	6.891414	51	6	.39	
38286.0	53.408 7	130.820 3	33.345 2	.11218 2	11.088766 2	.57E-5 12	6.890261	47	6	.43	
38290.0	72.945 7	117.673 3	33.344 1	.66745 2	11.088823 2	.88E-5 13	6.889141	44	6	.40	
38294.0	92.47 1	104.519 3	33.341 1	.18890 2	.82302 4	11.088890 2	.12E-4 12	6.888864	44	6	.42
38298.0	112.01 1	91.369 3	33.343 2	.18887 2	.17887 4	11.088954 2	.53E-5 14	6.889034	41	6	.45
38302.0	131.55 1	78.222 4	33.342 2	.18878 3	.53486 4	11.088989 3	.76E-5 23	6.889799	21	6	.50

Table 3

RELATIVE POSITIONS OF THE SUN AND THE PERIGEE OF SATELLITE 1959 ETA

MJD	Z	$\phi$	$\psi$	D. R.A.	$\dot{P}$
PERIGEE IN SUNLIGHT					
38214.	523.	28.7	34.9	321.5	-0.129E-06
38218.	516.	32.8	31.1	326.6	0.439E-07
38222.	517.	32.8	26.4	332.7	-0.130E-07
38226.	516.	28.5	21.4	337.7	-0.163E-08
38230.	514.	21.1	18.3	340.4	-0.179E-07
38234.	514.	11.5	20.1	341.1	0.309E-07
38238.	514.	1.0	26.4	340.6	-0.813E-08
38242.	516.	-9.7	34.2	340.0	-0.146E-07
38246.	519.	-19.5	41.4	340.6	-0.195E-07
38250.	522.	-27.5	46.6	343.2	-0.651E-08
38254.	524.	-32.3	48.6	348.2	-0.146E-07
38258.	525.	-33.1	47.1	354.7	-0.586E-07
38262.	523.	-29.6	42.1	0.5	-0.976E-07
38266.	521.	-22.7	34.0	4.1	-0.146E-07
38270.	518.	-13.4	23.7	5.4	-0.277E-07
38274.	515.	-2.9	12.4	5.4	0.976E-08
38278.	514.	7.8	5.2	5.1	-0.195E-07
38282.	515.	17.8	13.7	5.6	-0.520E-07
38286.	516.	26.2	23.7	7.9	-0.927E-07
38290.	517.	31.7	31.8	12.7	-0.143E-06
38294.	517.	33.3	37.2	19.1	-0.195E-06
38298.	516.	30.6	39.6	25.2	-0.862E-07
38302.	515.	24.3	39.0	29.3	-0.124E-06

T (MD)	$\omega$	$\Omega$	i	e	M	n	$n^{1/2}$	q	N	D	$\sigma$
38211.0	12.92 5	113.794 4	47.267 2	.05020 2	.8611 1	12.503501 5	.90E-4 9	7.447085	34 2	.38	
38212.0	16.82 4	110.501 8	47.262 4	.05009 2	.3648 1	12.503713 5	.-10E-3 9	7.447859	21 2	.34	
38213.0	20.88 4	107.186 6	47.268 3	.05037 2	.8681 1	12.503906 6	.-10E-3 1	7.445634	19 2	.32	
38214.0	24.75 4	103.907 6	47.254 3	.05036 2	.3721 1	12.504117 5	.-10E-3 9	7.445637	27 2	.35	
38215.0	28.64 4	100.602 5	47.254 3	.05057 2	.8763 1	12.504357 6	.-13E-3 1	7.443905	29 2	.43	
38216.0	32.62 5	97.287 5	47.263 3	.05078 2	.3805 1	12.504629 9	.-14E-3 1	7.442137	30 2	.49	
38217.0	36.57 5	93.981 5	47.263 3	.05100 2	.8851 1	12.504883 7	.-11E-3 1	7.440298	28 2	.48	
38218.0	40.49 6	90.687 7	47.257 5	.05120 3	.3900 2	12.505152 7	.-13E-3 1	7.438648	27 2	.56	
38219.0	44.34 5	87.389 5	47.250 4	.05135 2	.8953 1	12.505415 7	.-13E-3 1	7.437638	29 2	.49	
38220.0	48.17 7	84.079 6	47.253 5	.05155 3	.4010 2	12.505700 9	.-16E-3 2	7.435629	25 2	.52	
38221.0	52.21 7	80.766 8	47.265 7	.05181 4	.9064 2	12.50599 1	.-13E-3 3	7.433490	26 2	.60	
38222.0	56.08 6	77.465 6	47.262 5	.05204 3	.4125 2	12.50628 1	.-15E-3 2	7.431569	23 2	.60	
38223.0	59.95 7	74.164 6	47.260 6	.05228 4	.9189 2	12.50654 1	.-14E-3 2	7.429621	16 2	.59	
38224.0	63.76 6	70.865 5	47.257 5	.05253 3	.4257 2	12.50686 1	.-16E-3 2	7.427518	17 2	.52	
38225.0	67.70 6	67.566 4	47.255 5	.05280 3	.9325 2	12.50717 4	.-17E-3 5	7.425283	11 2	.35	
38226.0	71.57 7	64.264 6	47.258 6	.05307 3	.4397 2	12.50747 2	.-16E-3 3	7.423050	11 2	.46	
38227.0	75.46 8	60.959 6	47.260 7	.05333 4	.9473 2	12.50780 3	.-16E-3 5	7.420868	17 2	.57	
38228.0	79.2 1	57.655 6	47.257 7	.05354 5	.4557 3	12.50809 4	.-9E-4 5	7.419119	17 2	.74	
38229.0	82.93 7	54.360 5	47.256 5	.05368 4	.9642 2	12.50855 1	.-36E-3 3	7.417859	19 2	.51	
38230.0	86.83 7	51.053 5	47.264 5	.05403 4	.4729 2	12.50887 1	.-9E-4 2	7.414967	20 2	.54	
38231.0	90.69 5	47.752 3	47.266 4	.05432 3	.9818 1	12.509283 9	.-27E-3 1	7.412550	18 2	.43	
38232.0	94.53 4	44.447 2	47.264 3	.05454 2	.4914 1	12.509732 8	.-20E-3 1	7.410596	20 2	.42	
38233.0	98.28 4	41.142 2	47.261 3	.05475 2	.0016 1	12.510085 7	.-19E-3 1	7.408821	25 2	.47	
38234.0	102.10 9	37.839 5	47.256 5	.05495 4	.5120 3	12.51044 2	.-13E-3 3	7.407133	26 2	1.06	
38235.0	105.85 7	34.541 4	47.265 4	.05517 3	.0229 2	12.51078 1	.-20E-3 2	7.405287	19 2	.70	
38236.0	109.73 6	31.231 3	47.264 3	.05536 3	.5338 2	12.511131 9	.-18E-3 2	7.403673	19 2	.52	
38237.0	113.46 4	27.929 2	47.265 2	.05547 2	.0454 1	12.511475 6	.-16E-3 1	7.402618	23 2	.41	
38238.0	117.31 4	24.621 2	47.265 2	.05563 2	.5571 1	12.511825 8	.-18E-3 1	7.401235	20 2	.41	
38239.0	121.19 5	21.311 3	47.265 3	.05581 2	.0689 2	12.512140 9	.-15E-3 2	7.399746	18 2	.49	
38240.0	125.01 5	18.006 3	47.265 3	.05596 2	.5813 1	12.512499 8	.-19E-3 1	7.398392	21 2	.43	
38241.0	128.72 6	14.700 4	47.268 4	.05607 2	.0944 2	12.51283 1	.-16E-3 2	7.397420	18 2	.48	

## SAO mean elements -- Satellite 1960 Iota 1

1-31 August 1963

T (MJD)	$\omega$	$\Omega$	i	e	M	n	$n'/2$	$\eta$	N	D	$\sigma$
38242.0	132.48 4	11.393 3	47.265 4	.05617 2	.6076 1	12.513170 8	.15E-3 2	7.396474	15 2	.35	
38243.0	136.3 1	8.09 1	47.28 1	.05624 5	.1210 4	12.51355 2	.10E-3 5	7.395804	14 2	.91	
38244.0	140.0 4	4.78 2	47.29 2	.0564 1	.635 1	12.51390 6	.18E-3 9	7.394530	9 2	1.10	
38245.C	143.59 7	1.470 5	47.267 6	.05647 3	.1488 2	12.51422 1	.18E-3 2	7.393747	10 2	.45	
38246.0	147.88 7	358.156 6	47.261 5	.05662 3	.6630 2	12.51455 1	.16E-3 2	7.392416	15 2	.55	
38247.0	151.77 8	354.842 8	47.257 6	.05676 3	.1776 2	12.51491 1	.21E-3 2	7.391203	13 2	.58	
38248.0	155.65 9	351.529 7	47.258 6	.05690 3	.6926 3	12.51527 1	.16E-3 3	7.389953	13 2	.58	
38249.0	159.54 7	348.228 6	47.257 5	.05699 2	.2079 2	12.51565 1	.16E-3 2	7.389058	15 2	.51	
38250.0	163.40 4	344.921 4	47.260 3	.05710 2	.7236 1	12.51604 6	.20E-3 1	7.388070	17 2	.36	
38251.0	167.38 4	341.600 4	47.256 3	.05726 2	.2395 1	12.516398 6	.18E-3 1	7.386670	22 2	.37	
38252.0	171.21 5	338.289 5	47.257 3	.05738 2	.7561 1	12.516782 7	.20E-3 1	7.385566	21 2	.46	
38253.0	175.00 6	334.974 7	47.256 4	.05752 3	.2732 2	12.51718 1	.22E-3 3	7.384329	15 2	.49	
38254.0	178.90 5	331.655 5	47.257 3	.05770 2	.7904 1	12.51760 1	.19E-3 2	7.382785	17 2	.44	
38255.0	182.84 6	328.343 7	47.258 3	.05785 2	.3079 2	12.51803 1	.20E-3 2	7.381436	20 2	.56	
38256.0	186.71 5	325.033 6	47.262 3	.05805 2	.8260 2	12.518425 8	.24E-3 1	7.379695	23 2	.52	
38257.0	190.52 5	321.713 5	47.263 2	.05821 2	.3447 1	12.518903 7	.25E-3 1	7.378254	27 2	.52	
38258.0	194.45 5	318.393 5	47.263 2	.05841 2	.8636 1	12.519403 8	.28E-3 1	7.376485	27 2	.59	
38259.0	198.30 7	315.074 7	47.265 3	.05861 3	.3833 2	12.51997 1	.27E-3 2	7.374737	26 2	.79	
38260.0	202.21 8	311.747 7	47.267 3	.05889 3	.9032 2	12.52050 1	.34E-3 2	7.372301	25 2	.82	
38261.0	206.05 8	308.429 7	47.268 3	.05910 4	.4240 2	12.52112 1	.32E-3 2	7.370395	24 2	.81	
38262.0	209.84 7	305.113 5	47.270 3	.05927 3	.9456 2	12.52179 1	.33E-3 2	7.368785	23 2	.75	
38263.0	213.80 8	301.790 5	47.277 3	.05955 3	.4673 2	12.52240 1	.30E-3 2	7.366380	23 2	.72	
38264.0	217.56 5	298.478 4	47.278 2	.05973 3	.9902 2	12.523054 9	.37E-3 2	7.364681	27 2	.56	
38265.0	221.36 6	295.159 5	47.283 3	.05994 3	.5137 2	12.52371 1	.33E-3 2	7.362799	27 2	.73	
38266.C	225.1C 4	291.840 3	47.287 2	.06021 2	.0379 1	12.524333 6	.37E-3 1	7.360471	24 2	.45	
38267.0	228.96 6	288.522 5	47.293 3	.06039 3	.5625 2	12.52496 1	.31E-3 2	7.358836	26 2	.56	
38268.0	232.57 4	285.196 5	47.296 2	.06067 3	.0885 1	12.525561 8	.30E-3 1	7.356350	33 2	.47	
38269.0	236.45 4	281.879 5	47.299 2	.06083 3	.6141 1	12.526150 8	.32E-3 1	7.354919	34 2	.54	
38270.0	240.19 4	278.556 3	47.299 2	.06102 2	.1408 1	12.526671 6	.26E-3 1	7.353196	37 2	.40	
38271.C	243.97 3	275.237 2	47.298 2	.06113 2	.6679 1	12.527157 5	.205E-3 8	7.352128	46 2	.41	
38272.0	247.82 2	271.914 2	47.298 2	.06135 2	.19512 7	12.527526 5	.159E-3 8	7.350273	57 2	.45	

T (MJD)	$\omega$	$\Omega$	i	e	M	n	$n^{1/2}$	q	N	D	$\sigma$
38273.0	251.68 2	268.591 2	47.299 1	.06149 1	-72268 6	12.527814 4	.142E-3 7	7.349097	61	2	.42
38274.0	255.39 2	265.261 3	47.296 2	.06158 2	-25097 8	12.528110 5	.139E-3 8	7.348271	52	2	.45
38275.0	259.24 3	261.936 3	47.296 1	.06167 2	.77915 8	12.528400 5	.15E-3 1	7.347438	49	2	.43
38276.0	263.02 5	258.610 3	47.294 1	.06174 2	.3078 2	12.528697 6	.15E-3 1	7.346765	42	2	.42
38277.0	266.80 4	255.281 2	47.294 1	.06181 2	.8368 1	12.528991 5	.169E-3 9	7.346139	39	2	.43
38278.0	270.65 4	251.952 3	47.295 1	.06180 2	.3658 1	12.529299 5	.162E-3 9	7.346100	41	2	.49
38279.0	274.48 4	248.625 3	47.296 1	.06172 2	.8953 1	12.529610 6	.145E-3 9	7.346529	45	2	.48
38280.0	278.22 2	245.293 2	47.294 1	.06165 1	.42525 8	12.529916 4	.154E-3 8	7.346957	40	2	.42
38281.0	282.00 3	241.964 3	47.296 1	.06152 2	.95540 8	12.530213 5	.143E-3 9	7.347877	43	2	.49
38282.0	285.80 3	238.642 3	47.298 2	.06142 1	.48578 9	12.530482 6	.12E-3 1	7.348584	62	2	.56
38283.0	289.66 3	235.320 2	47.294 2	.06130 1	.0162 1	12.530684 6	.7E-4 1	7.349401	61	2	.54
38284.0	293.42 3	231.996 3	47.292 2	.06120 2	.5471 1	12.530814 8	.2E-4 1	7.350155	42	2	.48
38285.0	297.20 3	228.676 4	47.286 2	.06087 2	.07815 9	12.531011 8	.4E-4 1	7.352674	37	2	.58
38286.0	301.00 2	225.351 3	47.285 2	.06073 2	.60925 7	12.531153 8	.8E-4 1	7.353698	40	2	.45
38287.0	304.77 3	222.031 4	47.282 2	.06051 2	.14062 9	12.531370 7	.11E-3 1	7.355362	42	2	.49
38288.0	308.57 3	218.709 4	47.280 2	.06036 2	.67211 9	12.531582 8	.7E-4 1	7.356405	38	2	.47
38289.0	312.43 3	215.385 2	47.272 1	.06004 1	.20365 7	12.531865 7	.3E-4 1	7.358022	50	2	.41
38290.0	316.17 4	212.056 3	47.273 2	.05991 2	.7358 1	12.532079 7	.10E-3 1	7.359737	67	2	.67
38291.0	320.09 3	208.735 2	47.271 2	.05966 1	.26766 8	12.532346 6	.5E-4 1	7.361595	63	2	.46
38292.0	323.93 4	205.409 3	47.268 2	.05952 2	.80000 1	12.532584 7	.10E-3 1	7.362599	48	2	.53
38293.0	327.92 5	202.084 4	47.262 2	.05926 2	.3322 1	12.532896 8	.15E-3 1	7.364575	26	2	.47
38294.0	331.97 5	198.742 4	47.254 2	.05908 2	.8646 1	12.533222 8	.16E-3 1	7.365817	31	2	.47
38295.0	335.79 8	195.422 6	47.251 3	.05890 2	.3979 2	12.53371 1	.24E-3 2	7.367032	28	2	.67
38296.0	339.52 7	192.114 5	47.259 2	.05878 2	.9320 2	12.534179 8	.17E-3 2	7.367813	22	2	.54
38297.0	343.50 7	188.789 6	47.261 2	.05865 2	.4659 2	12.53453 1	.15E-3 2	7.368704	24	2	.55
38298.0	347.54 3	185.449 3	47.254 1	.05847 1	.99991 9	12.534914 5	.174E-3 9	7.369925	22	2	.26
38299.0	351.43 4	182.126 4	47.255 1	.05838 1	.5347 1	12.535291 6	.20E-3 1	7.370516	31	2	.38
38300.0	355.32 6	178.795 7	47.258 2	.05831 2	.0699 2	12.535635 9	.15E-3 2	7.370886	35	2	.58
38301.0	359.37 6	175.456 7	47.263 3	.05826 2	.6050 2	12.536062 9	.23E-3 2	7.371146	33	2	.62
38302.0	3.24 5	172.141 5	47.262 2	.05818 2	.1410 1	12.536469 7	.18E-3 1	7.371556	31	2	.54

Table 4 RELATIVE POSITIONS OF THE SUN AND THE PERIGEE OF SATELLITE 1960 IOTA 1					
MJD	Z	$\phi$	$\psi$	D.R.A.	P
PERIGEE IN SUNLIGHT					
38211.	1069.	9.5	26.3	23.4	-0.115E-05
38212.	1070.	12.3	23.4	21.8	-0.136E-05
38213.	1069.	15.2	20.8	20.4	-0.128E-05
38214.	1069.	17.9	18.5	19.0	-0.132E-05
38215.	1068.	20.6	16.5	17.6	-0.166E-05
38216.	1067.	23.3	15.1	16.4	-0.179E-05
38217.	1066.	26.0	14.3	15.3	-0.141E-05
38218.	1065.	28.5	14.2	14.3	-0.166E-05
38219.	1065.	30.9	14.7	13.5	-0.166E-05
38220.	1064.	33.2	15.6	12.8	-0.205E-05
38221.	1062.	35.5	17.1	12.5	-0.166E-05
38222.	1061.	37.6	18.7	12.2	-0.192E-05
38223.	1060.	39.5	20.4	12.2	-0.179E-05
38224.	1058.	41.2	22.0	12.3	-0.205E-05
38225.	1057.	42.8	23.7	12.9	-0.217E-05
38226.	1055.	44.2	25.3	13.5	-0.205E-05
38227.	1053.	45.3	26.7	14.5	-0.205E-05
38228.	1052.	46.2	27.9	15.4	-0.115E-05
38229.	1051.	46.8	29.0	16.4	-0.460E-05
38230.	1048.	47.2	30.0	17.8	-0.115E-05
38231.	1046.	47.3	30.8	19.2	-0.345E-05
38232.	1044.	47.1	31.4	20.5	-0.256E-05
38233.	1042.	46.6	31.7	21.6	-0.243E-05
38234.	1040.	45.9	31.9	22.8	-0.166E-05
38235.	1038.	45.0	31.8	23.7	-0.256E-05
38236.	1036.	43.7	31.6	24.5	-0.230E-05

Table 4 (cont.)

## RELATIVE POSITIONS OF THE SUN AND THE PERIGEE OF SATELLITE 1960 IOTA 1

MJD	Z	$\psi$	$\psi$	D.R.A.	$\dot{P}$
38237.	1034.	42.4	31.1	25.0	-0.204E-05
38238.	1032.	40.7	30.5	25.3	-0.230E-05
38239.	1030.	38.9	29.7	25.5	-0.192E-05
38240.	1028.	37.0	28.8	25.4	-0.243E-05
38241.	1026.	35.0	27.6	25.0	-0.204E-05
38242.	1024.	32.8	26.3	24.4	-0.192E-05
38243.	1023.	30.5	24.9	23.7	-0.128E-05
38244.	1021.	28.2	23.3	22.7	-0.230E-05
38245.	1019.	25.6	21.8	21.8	-0.230E-05
38246.	1017.	23.0	20.3	20.7	-0.204E-05
38247.	1015.	20.3	18.8	19.5	-0.268E-05
38248.	1014.	17.6	17.4	18.2	-0.204E-05
38249.	1012.	14.9	16.2	16.8	-0.204E-05
38250.	1011.	12.1	15.4	15.3	-0.255E-05
38251.	1009.	9.2	15.0	13.8	-0.230E-05
38252.	1007.	6.4	15.1	12.2	-0.255E-05
38253.	1006.	3.7	15.6	10.6	-0.281E-05
38254.	1004.	0.8	16.7	8.9	-0.243E-05
38255.	1003.	-2.1	18.3	7.4	-0.255E-05
38256.	1001.	-4.9	20.1	5.8	-0.306E-05
38257.	1000.	-7.7	22.1	4.1	-0.319E-05
38258.	999.	-10.6	24.4	2.6	-0.357E-05
38259.	997.	-13.3	26.8	1.1	-0.344E-05
38260.	996.	-16.1	29.2	359.6	-0.434E-05
38261.	994.	-18.8	31.6	358.3	-0.408E-05
38262.	993.	-21.4	34.0	356.9	-0.421E-05

Table 4 (cont.)

## RELATIVE POSITIONS OF THE SUN AND THE PERIGEE OF SATELLITE 1960 IOTA 1

MJD	Z	$\phi$	$\psi$	D.R.A.	P
38263.	992.	-24.1	36.4	355.8	-0.383E-05
38264.	991.	-26.6	38.7	354.7	-0.472E-05
38265.	989.	-29.0	40.9	353.8	-0.421E-05
38266.	988.	-31.4	43.0	353.0	-0.472E-05
38267.	987.	-33.7	45.0	352.4	-0.395E-05
38268.	985.	-35.7	46.7	351.8	-0.382E-05
38269.	985.	-37.8	48.5	351.6	-0.408E-05
38270.	984.	-39.6	49.9	351.6	-0.331E-05
38271.	983.	-41.3	51.2	351.8	-0.261E-05
38272.	982.	-42.9	52.3	352.3	-0.203E-05
38273.	981.	-44.2	53.2	353.0	-0.181E-05
38274.	981.	-45.3	53.9	353.8	-0.177E-05
38275.	980.	-46.2	54.3	354.9	-0.191E-05
38276.	980.	-46.8	54.5	356.1	-0.191E-05
38277.	979.	-47.2	54.4	357.4	-0.215E-05
38278.	979.	-47.3	54.1	358.9	-0.206E-05
38279.	980.	-47.1	53.5	0.3	-0.185E-05
38280.	980.	-46.7	52.7	1.5	-0.196E-05
38281.	981.	-46.0	51.7	2.6	-0.182E-05
38282.	981.	-45.0	50.4	3.6	-0.153E-05
38283.	981.	-43.8	48.9	4.5	-0.892E-06
38284.	982.	-42.4	47.2	5.1	-0.255E-06
38285.	983.	-40.8	45.2	5.5	-0.509E-06
38286.	984.	-39.0	43.1	5.6	-0.102E-05
38287.	985.	-37.1	40.8	5.6	-0.140E-05

Table 4 (cont.)

## RELATIVE POSITIONS OF THE SUN AND THE PERIGEE OF SATELLITE 1960 IOTA 1

MJD	Z	$\varphi$	$\psi$	D. R.A.	$\dot{P}$
38288.	985.	-35.1	38.4	5.3	-0.891E-06
38289.	987.	-32.8	35.8	4.9	-0.382E-06
38290.	987.	-30.6	33.1	4.1	-0.127E-05
38291.	988.	-28.1	30.1	3.4	-0.637E-06
38292.	988.	-25.6	27.2	2.5	-0.127E-05
38293.	989.	-23.0	24.1	1.5	-0.191E-05
38294.	990.	-20.2	20.9	0.5	-0.204E-05
38295.	991.	-17.5	17.8	359.1	-0.306E-05
38296.	991.	-14.9	15.0	357.7	-0.216E-05
38297.	991.	-12.0	12.1	356.3	-0.191E-05
38298.	992.	-9.1	9.7	354.9	-0.221E-05
38299.	992.	-6.3	8.3	353.4	-0.255E-05
38300.	993.	-3.4	8.4	351.8	-0.191E-05
38301.	993.	-0.5	9.8	350.3	-0.293E-05
38302.	993.	2.4	12.3	348.7	-0.229E-05

## I. SAO smoothed elements

The following elements are based on 148 observations and are valid for the period July 1 through August 1, 1963.

$$T_0 = 38226.0 \text{ MJD}$$

$$\omega = (298^\circ.150 \pm 8) + (2^\circ.8194 \pm 7)t - .000179t^2 + .3431 \cos \omega$$

$$\Omega = (286^\circ.384 \pm 1) - (3^\circ.38972 \pm 9)t - .172 \times 10^{-4}t^2 + .0143 \cos \omega$$

$$i = (49^\circ.9475 \pm 7) - .579 \times 10^{-4}t - .0043 \sin \omega$$

$$e = (.11874 \pm 1) + .727 \times 10^{-5}t + .0007285 \sin \omega$$

$$M = (.79522 \pm 3) + (12.812615 \pm 2)t + (.711 \pm 3) \times 10^{-5}t^2 \\ + (.81 \pm 3) \times 10^{-7}t^3 - .0008799 \cos \omega$$

Standard error of one observation:  $\sigma = \pm 1.18$ .

The following elements are based on 183 observations and are valid for the period August 1 through September 1, 1963.

$$T_0 = 38256.0 \text{ MJD}$$

$$\omega = (22^\circ.684 \pm 5) + (2^\circ.8183 \pm 5)t - .000179t^2 + .3431 \cos \omega$$

$$\Omega = (184^\circ.678 \pm 1) - (3^\circ.3906 \pm 1)t - .172 \times 10^{-4}t^2 + .0143 \cos \omega$$

$$i = (49^\circ.946 \pm 1) - .579 \times 10^{-4}t - .0043 \sin \omega$$

$$e = (.11885 \pm 2) + .727 \times 10^{-5}t + .0007285 \sin \omega$$

$$M = (.18237 \pm 2) + (12.813272 \pm 1)t + (.1589 \pm 3) \times 10^{-4}t^2 \\ + (.150 \pm 3) \times 10^{-6}t^3 - .0008799 \cos \omega$$

Standard error of one observation:  $\sigma = \pm 1.80$ .

The following elements are based on 156 observations and are valid for the period September 1 through October 1, 1963.

$$T_0 = 38288.0 \text{ MJD}$$

$$\omega = (112^\circ 812 \pm 7) + (2^\circ 8165 \pm 8)t - 000179t^2 + 3431 \cos \omega$$

$$\Omega = (76^\circ 165 \pm 1) - (3^\circ 3915 \pm 2)t - 172 \times 10^{-4} t^2 + 0143 \cos \omega$$

$$i = (49^\circ 951 \pm 1) - 579 \times 10^{-4} t - 0043 \sin \omega$$

$$e = (.11891 \pm 1) + .727 \times 10^{-5} t + .0007285 \sin \omega$$

$$M = (.22441 \pm 2) + (12.814322 \pm 3)t + (.272 \pm 1) \times 10^{-4} t^2 + (.86 \pm 2) \times 10^{-6} t^3 \\ - (.109 \pm 5) \times 10^{-7} t^4 - (.155 \pm 5) \times 10^{-8} t^5 - .0008799 \cos \omega$$

Standard error of one observation:  $\sigma = \pm 1.53$ .

## III. SAO mean elements -- Satellite 1960 Xi 1

4 July - 30 September 1963

T (MJD)	w	Ω	i	e	M	n	n'/2	q	N	D	σ
38214.0	264.32 8	327.058 8	49.96 1	.1183 5	.0445 4	12.812457 3	.4E-5 2	6.801609	16	6	.51
38218.0	275.65 7	313.50 1	49.95 1	.1181 4	.2945 3	12.812507 3	.7E-5 2	6.803137	21	6	.52
38222.0	286.96 4	299.953 9	49.955 6	.1180 2	.5446 2	12.812553 2	.7E-5 1	6.803799	22	6	.41
38226.0	298.30 3	286.39 1	49.954 6	.1180 2	.7949 2	12.812598 2	.3E-5 2	6.804022	24	6	.38
38230.0	309.66 1	272.837 5	49.951 2	.11825 3	.04516 4	12.812659 3	.1E-4 1	6.802041	26	6	.36
38234.0	320.945 8	259.277 2	49.950 1	.11839 2	.29595 2	12.812736 2	.124E-4 8	6.800903	36	6	.44
38238.0	332.243 5	245.719 1	49.9504 9	.11853 1	.54702 1	12.8128124 8	.73E-5 5	6.799845	42	6	.43
38242.0	343.558 5	232.157 1	49.946 1	.11863 2	.79832 1	12.812896 1	.145E-4 7	6.799034	52	6	.45
38246.0	354.832 5	218.599 1	49.9466 9	.11883 3	.05013 2	12.813017 1	.118E-4 7	6.797477	42	6	.42
38250.0	6.096 6	205.038 2	49.943 2	.11895 3	.30242 2	12.813131 2	.15E-4 1	6.796458	43	6	.36
38254.0	17.37 1	191.472 2	49.944 2	.11907 3	.55513 4	12.813233 2	.11E-4 1	6.795536	25	6	.44
38258.0	28.61 1	177.901 3	49.942 2	.11916 3	.80829 3	12.813326 2	.15E-4 2	6.794792	33	6	.46
38262.0	39.85 1	164.339 3	49.942 2	.11933 3	.06187 4	12.813490 2	.25E-4 1	6.793399	33	6	.52
38266.0	51.05 1	150.785 3	49.942 1	.11943 3	.31631 3	12.813665 1	.188E-4 9	6.792606	36	6	.43
38270.0	62.272 9	137.211 3	49.946 2	.11956 2	.57132 2	12.813816 1	.17E-4 7	6.791527	34	6	.44
38274.0	73.46 1	123.649 6	49.942 5	.11958 3	.82698 4	12.813942 2	.12E-4 1	6.791343	18	6	.52
38278.0	84.66 2	110.082 4	49.941 6	.11958 6	.08301 6	12.814036 3	.15E-4 1	6.791311	12	6	.49
38282.0	95.86 1	96.514 3	49.945 3	.11967 4	.33937 5	12.814141 4	.15E-4 2	6.790552	22	6	.47
38286.0	107.06 2	82.954 4	49.950 3	.11965 4	.59614 7	12.814273 4	.26E-4 2	6.790692	23	6	.50
38290.0	118.30 2	69.377 3	49.946 3	.11956 2	.85352 7	12.814505 3	.29E-4 2	6.791259	42	6	.57
38294.0	129.51 2	55.805 2	49.944 3	.11949 2	.11195 6	12.814762 2	.40E-4 1	6.791747	52	6	.61
38298.0	140.71 2	42.240 3	49.951 3	.11938 3	.37159 6	12.815051 2	.23E-4 1	6.792448	38	6	.52
38302.0	151.95 2	28.670 3	49.948 2	.11924 2	.63198 5	12.815218 2	.18E-4 1	6.793484	37	6	.45

Table 5

## RELATIVE POSITIONS OF THE SUN AND THE PERIGEE OF SATELLITE 1960 XI 1

MJD	Z	$\varphi$	$\psi$	D.R.A.	$\dot{P}$
PERIGEE IN EARTH SHADOW					
38214.	436.	-49.6	130.3	126.0	-0.487E-07
38218.	437.	-49.6	130.0	125.8	-0.853E-07
38222.	437.	-47.1	129.5	124.8	-0.853E-07
38226.	435.	-42.4	127.5	121.7	-0.365E-07
38230.	431.	-36.1	123.1	116.4	-0.122E-06
38234.	428.	-28.8	115.8	109.1	-0.151E-06
PERIGEE IN SUNLIGHT					
38238.	424.	-20.9	106.1	100.5	-0.889E-07
38242.	422.	-12.5	94.8	90.9	-0.177E-06
38246.	419.	-4.0	82.5	80.9	-0.144E-06
38250.	418.	4.7	70.3	70.8	-0.183E-06
38254.	418.	13.2	58.9	60.9	-0.134E-06
38258.	419.	21.5	49.5	51.5	-0.183E-06
38262.	420.	29.4	43.4	43.1	-0.305E-06
38266.	422.	36.5	41.3	36.2	-0.229E-06
38270.	423.	42.7	42.7	31.2	-0.207E-06
38274.	425.	47.2	45.8	28.4	-0.146E-06
38278.	425.	49.6	48.8	27.8	-0.183E-06
38282.	425.	49.6	50.2	27.9	-0.183E-06
38286.	424.	47.0	49.2	27.2	-0.317E-06
38290.	423.	42.4	45.7	24.5	-0.353E-06
38294.	421.	36.2	39.8	19.4	-0.487E-06
38298.	419.	29.0	32.2	12.5	-0.280E-06
38302.	418.	21.1	23.9	4.1	-0.219E-06

## I. SAO smoothed elements

The following elements are based on 123 observations and are valid for the period July 1 through July 9, 1963.

$$T_0 = 38215.0 \text{ MJD}$$

$$\omega = (316^\circ 435 \pm 6) + (4^\circ 924 \pm 2)t + .000143t^2 + .2242 \cos \omega$$

$$\Omega = (230^\circ 700 \pm 2) - (3^\circ 7858 \pm 6)t - .000296t^2 + .0072 \cos \omega$$

$$i = (38^\circ 9175 \pm 8) - .344 \times 10^{-4}t - .0049 \sin \omega$$

$$e = (.12968 \pm 2) + (.10 \pm 6) \times 10^{-4}t - .22 \times 10^{-7}t^2 + .0005261 \sin \omega$$

$$M = (.18732 \pm 1) + (12.347384 \pm 5)t + (.000302 \pm 1)t^2 + (.115 \pm 6) \times 10^{-4}t^3 \\ - (.81 \pm 9) \times 10^{-6}t^4 - (.14 \pm 3) \times 10^{-6}t^5 - .0006329 \cos \omega$$

Standard error of one observation:  $\sigma = \pm 1^\circ 28$ .

The following elements are based on 152 observations and are valid for the period July 9 through July 16, 1963.

$$T_0 = 38223.0 \text{ MJD}$$

$$\omega = (355^\circ 839 \pm 3) + (4^\circ 936 \pm 1)t + .000143t^2 + .2242 \cos \omega$$

$$\Omega = (200^\circ 406 \pm 1) - (3^\circ 7886 \pm 5)t - .000296t^2 + .0072 \cos \omega$$

$$i = (38^\circ 9235 \pm 5) - .344 \times 10^{-4}t - .0049 \sin \omega$$

$$e = (.12993 \pm 1) + (.37 \pm 6) \times 10^{-4}t - .22 \times 10^{-7}t^2 + .0005261 \sin \omega$$

$$M = (.986843 \pm 7) + (12.352346 \pm 3)t + (.0002782 \pm 7)t^2 - (.11 \pm 4) \times 10^{-5}t^3 \\ + (.85 \pm 5) \times 10^{-6}t^4 + (.50 \pm 22) \times 10^{-7}t^5 - .0006329 \cos \omega$$

Standard error of one observation:  $\sigma = \pm 1^\circ 08$ .

The following elements are based on 102 observations and are valid for the period July 16 through July 24, 1963.

$$T_0 = 38230.0 \text{ MJD}$$

$$\omega = (30^\circ 438 \pm 6) + (4^\circ 947 \pm 2)t + ^\circ 000143t^2 + ^\circ 2242 \cos \omega$$

$$\Omega = (173^\circ 880 \pm 3) - (3^\circ 792 \pm 1)t - ^\circ 000296t^2 + ^\circ 0072 \cos \omega$$

$$i = (38^\circ 924 \pm 1) - ^\circ 344 \times 10^{-4}t - ^\circ 0049 \sin \omega$$

$$e = (.13032 \pm 3) + (.52 \pm 8) \times 10^{-4}t - .22 \times 10^{-7}t^2 + .0005261 \sin \omega$$

$$M = (.46993 \pm 2) + (12.357823 \pm 6)t + (.000462 \pm 1)t^2 - (.52 \pm 6) \times 10^{-5}t^3 \\ + (.104 \pm 8) \times 10^{-5}t^4 + (.19 \pm 2) \times 10^{-6}t^5 - .0006329 \cos \omega$$

Standard error of one observation:  $\sigma = \pm 1^\circ 68$ .

The following elements are based on 64 observations and are valid for the period July 24 through August 1, 1963.

$$T_0 = 38238.0 \text{ MJD}$$

$$\omega = (70^\circ 063 \pm 4) + (4^\circ 963 \pm 2)t + ^\circ 000143t^2 + ^\circ 2242 \cos \omega$$

$$\Omega = (143^\circ 520 \pm 2) - (3^\circ 799 \pm 1)t - ^\circ 000296t^2 + ^\circ 0072 \cos \omega$$

$$i = (38^\circ 9264 \pm 8) - ^\circ 344 \times 10^{-4}t - ^\circ 0049 \sin \omega$$

$$e = (.13062 \pm 2) + (.37 \pm 7) \times 10^{-4}t - .22 \times 10^{-7}t^2 + .0005261 \sin \omega$$

$$M = (.364757 \pm 9) + (12.365963 \pm 4)t + (.000453 \pm 1)t^2 - (.22 \pm 6) \times 10^{-5}t^3 \\ + (.276 \pm 6) \times 10^{-5}t^4 + (.23 \pm 3) \times 10^{-6}t^5 - .0006329 \cos \omega$$

Standard error of one observation:  $\sigma = \pm 1^\circ 15$ .

The following elements are based on 51 observations and are valid for the period August 1 through August 9, 1963.

$$T_0 = 38246.0 \text{ MJD}$$

$$\omega = (109^\circ 661 \pm 4) + (4^\circ 957 \pm 2)t + ^\circ 000143t^2 + ^\circ 2242 \cos \omega$$

$$\Omega = (113^\circ 100 \pm 2) - (3^\circ 8071 \pm 7)t - ^\circ 000296t^2 + ^\circ 0072 \cos \omega$$

$$i = (38^\circ 928 \pm 1) - ^\circ 344 \times 10^{-4}t - ^\circ 0049 \sin \omega$$

$$e = (.13098 \pm 2) + (.55 \pm 7) \times 10^{-4}t - .22 \times 10^{-7}t^2 + .0005261 \sin \omega$$

$$M = (.329472 \pm 9) + (12.375582 \pm 4)t + (.000608 \pm 1)t^2 + (.19 \pm 54) \times 10^{-6}t^3 \\ - (.35 \pm 10) \times 10^{-6}t^4 - (.18 \pm 3) \times 10^{-6}t^5 - .0006329 \cos \omega$$

Standard error of one observation:  $\sigma = \pm 1^\circ 08$ .

The following elements are based on 44 observations and are valid for the period August 9 through August 16, 1963.

$$T_0 = 38254.0 \text{ MJD}$$

$$\omega = (149^\circ 327 \pm 6) + (4^\circ 955 \pm 3)t + ^\circ 000143t^2 + ^\circ 2242 \cos \omega$$

$$\Omega = (82^\circ 625 \pm 4) - (3^\circ 8126 \pm 8)t - ^\circ 000296t^2 + ^\circ 0072 \cos \omega$$

$$i = (38^\circ 928 \pm 2) - ^\circ 344 \times 10^{-4}t - ^\circ 0049 \sin \omega$$

$$e = (.13137 \pm 2) + (.53 \pm 8) \times 10^{-4}t - .22 \times 10^{-7}t^2 + .0005261 \sin \omega$$

$$M = (.36980 \pm 1) + (12.384052 \pm 7)t + (.000458 \pm 2)t^2 - (.15 \pm 12) \times 10^{-5}t^3 \\ + (.53 \pm 16) \times 10^{-6}t^4 - (.76 \pm 68) \times 10^{-7}t^5 - .0006329 \cos \omega$$

Standard error of one observation:  $\sigma = \pm 1^\circ 10$ .

The following elements are based on 55 observations and are valid for the period August 16 through August 24, 1963.

$$T_0 = 38261.0 \text{ MJD}$$

$$\omega = (184^\circ 02 \pm 2) + (4^\circ 989 \pm 8)t + ^\circ 000718t^2 + ^\circ 2242 \cos \omega$$

$$\Omega = (55^\circ 907 \pm 4) - (3^\circ 819 \pm 1)t - ^\circ 000943t^2 + ^\circ 0072 \cos \omega$$

$$i = (38^\circ 934 \pm 3) + ^\circ 24 \times 10^{-4}t - ^\circ 0049 \sin \omega$$

$$e = (.13151 \pm 5) + (.35 \pm 20) \times 10^{-4}t - .139 \times 10^{-5}t^2 + .0005261 \sin \omega$$

$$M = (.08323 \pm 8) + (12.39240 \pm 3)t + (.000962 \pm 3)t^2 + (.20 \pm 2) \times 10^{-4}t^3 \\ - (.45 \pm 2) \times 10^{-5}t^4 + (.12 \pm 7) \times 10^{-6}t^5 - .0006329 \cos \omega$$

Standard error of one observation:  $\sigma = \pm 1^\circ 60$ .

The following elements are based on 56 observations and are valid for the period August 24 through September 1, 1963.

$$T_0 = 38269.0 \text{ MJD}$$

$$\omega = (223^\circ 921 \pm 7) + (4^\circ 978 \pm 2)t + ^\circ 000718t^2 + ^\circ 2242 \cos \omega$$

$$\Omega = (25^\circ 314 \pm 4) - (3^\circ 832 \pm 1)t - ^\circ 000943t^2 + ^\circ 0072 \cos \omega$$

$$i = (38^\circ 936 \pm 3) + ^\circ 24 \times 10^{-4}t - ^\circ 0049 \sin \omega$$

$$e = (.13188 \pm 3) + (.94 \pm 89) \times 10^{-5}t - .139 \times 10^{-5}t^2 + .0005261 \sin \omega$$

$$M = (.28368 \pm 2) + (12.407454 \pm 7)t + (.000909 \pm 3)t^2 - (.95 \pm 10) \times 10^{-5}t^3 \\ - (.24 \pm 2) \times 10^{-5}t^4 + (.21 \pm 5) \times 10^{-6}t^5 - .0006329 \cos \omega$$

Standard error of one observation:  $\sigma = \pm 1^\circ 43$ .

The following elements are based on 63 observations and are valid for the period September 1 through September 8, 1963.

$$T_0 = 38277.0 \text{ MJD}$$

$$\omega = (263^\circ 776 \pm 4) + (4^\circ 988 \pm 1)t + .000718t^2 + .2242 \cos \omega$$

$$\Omega = (354^\circ 627 \pm 3) - (3^\circ 840 \pm 1)t - .000943t^2 + .0072 \cos \omega$$

$$i = (38^\circ 936 \pm 1) + .24 \times 10^{-4}t - .0049 \sin \omega$$

$$e = (.13217 \pm 2) + (.58 \pm 5) \times 10^{-4}t - .139 \times 10^{-5}t^2 + .0005261 \sin \omega$$

$$M = (.593422 \pm 9) + (12.419122 \pm 5)t + (.000628 \pm 2)t^2 + (.18 \pm 11) \times 10^{-5}t^3 \\ - (.03 \pm 15) \times 10^{-6}t^4 - (.18 \pm 7) \times 10^{-6}t^5 - .0006329 \cos \omega$$

Standard error of one observation:  $\sigma = \pm 0^\circ 90$ .

The following elements are based on 70 observations and are valid for the period September 8 through September 16, 1963.

$$T_0 = 38284.0 \text{ MJD}$$

$$\omega = (298^\circ 717 \pm 5) + (4^\circ 993 \pm 2)t + .000718t^2 + .2242 \cos \omega$$

$$\Omega = (327^\circ 721 \pm 3) - (3^\circ 846 \pm 1)t - .000943t^2 + .0072 \cos \omega$$

$$i = (38^\circ 9358 \pm 9) + .24 \times 10^{-4}t - .0049 \sin \omega$$

$$e = (.13245 \pm 2) + (.16 \pm 6) \times 10^{-4}t - .139 \times 10^{-5}t^2 + .0005261 \sin \omega$$

$$M = (.55898 \pm 1) + (12.428460 \pm 7)t + (.000717 \pm 2)t^2 + (.131 \pm 9) \times 10^{-4}t^3 \\ + (.48 \pm 1) \times 10^{-5}t^4 + (.55 \pm 5) \times 10^{-6}t^5 - .0006329 \cos \omega$$

Standard error of one observation:  $\sigma = \pm 1^\circ 18$ .

The following elements are based on 72 observations and are valid for the period September 16 through September 23, 1963.

$$T_0 = 38292.0 \text{ MJD}$$

$$\omega = (338^\circ 72 \pm 1) + (5^\circ 049 \pm 7)t + .000718t^2 + .2242 \cos \omega$$

$$\Omega = (296^\circ 897 \pm 5) - (3^\circ 860 \pm 2)t - .000943t^2 + .0072 \cos \omega$$

$$i = (38^\circ 940 \pm 2) + .24 \times 10^{-4}t - .0049 \sin \omega$$

$$e = (.13239 \pm 4) - (.36 \pm 21) \times 10^{-4}t - .139 \times 10^{-5}t^2 + .0005261 \sin \omega$$

$$M = (.05606 \pm 3) + (12.44773 \pm 2)t + (.001447 \pm 3)t^2 + (.49 \pm 2) \times 10^{-4}t^3 \\ + (.158 \pm 2) \times 10^{-4}t^4 + (.17 \pm 1) \times 10^{-5}t^5 - .0006329 \cos \omega$$

Standard error of one observation:  $\sigma = \pm 1.65$ .

The following elements are based on 47 observations and are valid for the period September 23 through October 1, 1963.

$$T_0 = 38299.0 \text{ MJD}$$

$$\omega = (13^\circ 89 \pm 2) + (5^\circ 060 \pm 8)t + .000718t^2 + .2242 \cos \omega$$

$$\Omega = (269^\circ 797 \pm 5) - (3^\circ 878 \pm 2)t - .000943t^2 + .0072 \cos \omega$$

$$i = (38^\circ 950 \pm 4) + .24 \times 10^{-4}t - .0049 \sin \omega$$

$$e = (.13155 \pm 7) - (.45 \pm 21) \times 10^{-6}t + .139 \times 10^{-5}t^2 + .0005261 \sin \omega$$

$$M = (.29522 \pm 9) + (12.47665 \pm 4)t + (.001660 \pm 7)t^2 + (.28 \pm 3) \times 10^{-4}t^3 \\ + (.12 \pm 5) \times 10^{-5}t^4 - (.16 \pm 1) \times 10^{-5}t^5 - .0006329 \cos \omega$$

Standard error of one observation:  $\sigma = \pm 1.65$ .

## II. SAO mean elements -- Satellite 1961 Delta 1

1-31 July 1963

T (MJD)	$\omega$	$\Omega$	e	i	M	n	$n'/2$	q	N	D	$\sigma$
38211.0	296.861	245.847 9	38.919 2	.12900 6	.80156 5	12.34531 1	.30E-3 2	6.886917	21	2	.45
38212.0	301.801	242.057 4	38.917 2	.12906 4	.14717 3	12.345867 8	.25E-3 1	6.886252	20	2	.44
38213.0	3C6.771	238.270 3	38.916 1	.12907 4	.49320 3	12.346326 7	.21E-3 1	6.886019	20	2	.35
38214.0	311.646 7	234.494 2	38.9203 9	.12923 2	.83987 2	12.346772 5	.254E-3 7	6.884563	26	2	.29
38215.C	316.582 8	230.708 3	38.920 1	.12933 3	.18688 2	12.347338 5	.347E-3 7	6.883597	21	2	.35
38216.C	321.511	226.915 7	38.922 2	.12937 4	.53459 3	12.347987 7	.36E-3 1	6.883021	18	2	.34
38217.0	326.433 9	223.136 4	38.922 1	.12943 3	.88295 2	12.348675 5	.325E-3 7	6.88297	29	2	.35
38218.0	331.391	219.346 4	38.923 1	.12950 3	.23190 2	12.349311 5	.320E-3 7	6.881524	33	2	.45
38219.0	336.323 8	215.565 3	38.924 1	.12955 3	.58151 2	12.349931 6	.32E-3 1	6.880849	42	2	.46
38220.0	341.252 5	211.776 2	38.9230 9	.12965 2	.93178 1	12.350569 3	.305E-3 5	6.879836	43	2	.35
38221.C	346.192 4	207.985 1	38.9233 7	.12977 2	.282643 9	12.351190 2	.315E-3 4	6.878699	36	2	.28
38222.C	351.115 5	204.195 2	38.9225 8	.12978 2	.63420 1	12.351792 3	.303E-3 4	6.878396	36	2	.32
38223.C	356.045 6	200.413 3	38.924 1	.12991 2	.98626 1	12.352347 3	.271E-3 5	6.877109	36	2	.42
38224.0	.993 6	196.627 2	38.9269 9	.13001 2	.33883 1	12.352899 3	.291E-3 5	6.876099	35	2	.40
38225.0	5.933 6	192.839 3	38.9269 1	.13004 3	.69203 2	12.353493 5	.293E-3 8	6.875668	26	2	.41
38226.C	1C.870 7	189.047 3	38.923 1	.13017 3	.04580 2	12.354103 6	.327E-3 8	6.874424	37	2	.45
38227.C	15.804 7	185.259 3	38.923 1	.13031 3	.40022 2	12.354897 3	.479E-3 5	6.872987	44	2	.51
38228.C	2C.752 7	181.467 3	38.925 1	.13032 3	.75561 2	12.355935 4	.534E-3 6	6.872697	30	2	.46
38229.0	25.7C 1	177.671 4	38.925 2	.13036 6	.11207 4	12.356963 7	.487E-3 9	6.871842	24	2	.54
38230.0	3C.630 9	173.879 4	38.927 2	.13042 5	.46952 3	12.357864 7	.41E-3 1	6.871051	22	2	.53
38231.C	35.561 9	170.088 5	38.924 3	.13058 5	.82777 3	12.358654 6	.403E-3 9	6.869519	21	2	.53
38232.0	4C.490 9	166.288 5	38.923 2	.13071 5	.18688 2	12.359662 6	.581E-3 9	6.868082	16	2	.42
38233.0	45.421	162.505 6	38.925 3	.13075 6	.54712 3	12.360752 8	.51E-3 2	6.867379	17	2	.58
38234.C	5C.361	158.714 5	38.925 2	.13083 5	.90839 2	12.361839 9	.60E-3 1	6.866313	16	2	.53
38235.C	55.305 5	154.920 3	38.924 1	.13091 3	.27081 1	12.363021 4	.560E-3 5	6.865247	17	2	.27
38236.0	6C.242 6	151.121 4	38.923 1	.13096 4	.63441 2	12.364102 6	.52E-3 1	6.864513	18	2	.39
38237.0	65.182 8	147.324 4	38.922 2	.13105 5	.99900 2	12.365077 5	.49E-3 1	6.863420	17	2	.49
38238.C	7C.120 8	143.524 4	38.922 1	.13111 5	.36458 2	12.366065 7	.48E-3 1	6.862586	13	2	.43
38239.C	75.046 8	139.724 4	38.921 1	.13119 5	.73116 2	12.36697 1	.40E-3 3	6.861612	15	2	.43
38240.C	79.983 9	135.915 5	38.919 2	.13121 4	.09855 2	12.367870 7	.54E-3 1	6.861069	18	2	.56
38241.0	84.921	132.115 6	38.919 2	.13132 5	.46701 2	12.36918 1	.74E-3 2	6.859742	12	2	.49

T (MJD)	ω	Ω	i	e	M	n	n'/2	q	N	D	σ
38242.0	85.84 1	128.334 7	38.927 2	.13132 4	.83690 4	12.370593 8	*71E-3 1	6.859214	13 2	.25	
38243.0	94.76 1	124.530 7	38.927 2	.13140 4	.20827 2	12.371941 8	*67E-3 1	6.858135	15 2	.27	
38244.0	99.73 1	120.707 8	38.921 2	.13143 8	.58080 4	12.37321 2	*60E-3 2	6.857383	11 2	.55	
38245.0	104.64 2	116.911 1	38.920 5	.13142 8	.95466 4	12.37437 4	*60E-3 6	6.857083	7 2	.76	
38246.0	109.58 1	113.103 7	38.924 3	.13155 6	.32966 2	12.375603 8	*63E-3 1	6.855602	11 2	.50	
38247.0	114.518 7	109.295 5	38.924 2	.13155 4	.70592 2	12.37685 1	*62E-3 1	6.855092	14 2	.40	
38248.0	115.46 1	105.480 8	38.926 2	.13155 4	.08339 2	12.37803 1	*59E-3 2	6.854700	9 2	.39	
38249.0	124.413 9	101.663 6	38.924 2	.13149 4	.46199 1	12.379151 9	*56E-3 1	6.854727	10 2	.28	
38250.0	129.340 7	97.864 4	38.924 2	.13160 3	.84167 2	12.380173 8	*52E-3 1	6.853442	12 2	.37	
38251.0	134.28 1	94.052 4	38.927 3	.13165 3	.222237 3	12.38121 1	*54E-3 2	6.852718	8 2	.36	
38252.0	135.16 9	90.24 1	38.925 3	.1312 2	.6044 4	12.38215 4	*59E-3 6	6.855618	6 2	.25	
38253.0	144.19 1	86.451 9	38.920 2	.13160 4	.986662 2	12.383161 9	*45E-3 2	6.852373	11 2	.33	
38254.0	149.09 2	82.65 1	38.919 3	.13170 5	.37038 3	12.38407 1	*43E-3 2	6.851281	11 2	.36	
38255.0	154.09 1	78.808 9	38.923 4	.13168 5	.75484 2	12.38500 1	*47E-3 1	6.851052	12 2	.45	
38256.0	159.04 2	74.99 1	38.924 5	.13164 7	.14029 3	12.38578 2	*41E-3 2	6.851067	14 2	.57	
38257.0	163.95 7	71.16 1	38.933 5	.1317 1	.5268 3	12.38668 4	*49E-3 2	6.850619	13 2	.46	
38258.0	168.83 9	67.37 1	38.919 6	.1315 2	.9143 3	12.38780 4	*59E-3 3	6.851550	13 2	.50	
38259.0	173.7 1	63.58 2	38.906 9	.1311 3	.3032 4	12.38900 4	*64E-3 2	6.854255	12 2	.45	
38260.0	178.8 1	59.71 1	38.938 8	.1315 2	.6923 4	12.39055 5	*85E-3 2	6.850518	12 2	.52	
38261.0	183.77 9	55.90 1	38.940 9	.1313 2	.0839 3	12.39222 6	*84E-3 6	6.851461	11 2	.46	
38262.0	188.9 2	52.05 2	38.96 2	.1316 5	.4769 7	12.39455 7	*105E-2 3	6.848334	10 2	.55	
38263.0	193.82 1	48.254 3	38.936 3	.13147 5	.87252 3	12.39641 2	*91E-3 1	6.848537	15 2	.46	
38264.0	198.794 9	44.436 3	38.930 3	.13149 5	.26987 2	12.39814 3	*83E-3 3	6.847738	15 2	.46	
38265.0	203.7 1	40.613 5	38.944 9	.1315 2	.6691 4	12.40015 3	*98E-3 7	6.847250	13 2	.47	
38266.0	208.78 4	36.796 5	38.957 1	.1314 1	.0701 2	12.40201 3	*91E-3 7	6.847128	11 2	.53	
38267.0	213.74 2	32.960 6	38.92 1	.1316 1	.47311 7	12.40384 5	*95E-3 8	6.844509	5 2	.27	
38268.0	218.70 1	29.140 5	38.950 7	.13148 8	.87796 5	12.40554 3	*79E-3 4	6.845047	7 2	.28	
38269.0	223.73 2	25.31 1	38.935 6	.13152 5	.28427 3	12.40732 2	*91E-3 5	6.844119	8 2	.51	
38270.0	228.76 2	21.45 1	38.928 6	.13153 4	.69246 3	12.40917 1	*95E-3 6	6.843344	9 2	.52	
38271.0	233.75 2	17.638 8	38.939 6	.13146 5	.10252 3	12.41089 1	*72E-3 3	6.843231	14 2	.46	
38272.0	238.76 2	13.806 8	38.939 8	.13140 9	.51415 5	12.41241 1	*75E-3 3	6.843205	18 2	.44	

## II. SAO mean elements -- Satellite 1961 Delta 1

1-30 September 1963

T (MD)	$\omega$	$\Omega$	i	e	M	n	$n'/2$	q	N	D	$\sigma$
38273.0	243.741 9	9.960 7	38.933 4	.13146 4	-92734 2	12.413872 9	.75E-3 2	6.842177	20	2	.46
38274.0	248.744 8	6.133 6	38.939 3	.13150 4	.34192 2	12.41529 1	.66E-3 2	6.841349	16	2	.40
38275.0	253.749 9	2.303 9	38.947 6	.13144 5	.75784 3	12.41655 2	.63E-3 2	6.841317	14	2	.30
38276.0	258.751	358.461	38.938 6	.13170 6	.117501 5	12.41779 3	.61E-3 2	6.838848	16	2	.38
38277.0	263.741	354.642	38.945 7	.13174 9	.59351 6	12.41910 4	.61E-3 3	6.838009	12	2	.52
38278.0	268.767 8	350.777 8	38.938 3	.13170 4	.01318 2	12.420330 8	.66E-3 2	6.837908	15	2	.42
38279.0	273.798 8	346.928 8	38.937 2	.13177 8	.43409 2	12.42157 2	.62E-3 2	6.836902	17	2	.33
38280.C	278.768 7	343.059 8	38.939 2	.13165 5	.85639 3	12.42280 3	.59E-3 3	6.835830	18	2	.35
38281.C	283.798 8	339.253 9	38.939 2	.13188 6	.27978 3	12.42417 2	.74E-3 2	6.835112	21	2	.39
38282.C	288.7 1	335.432	38.945 5	.1317 2	.7051 4	12.42558 3	.71E-3 2	6.835651	19	2	.42
38283.0	293.803 7	331.570 8	38.940 2	.13192 6	.13104 3	12.42697 2	.68E-3 1	6.833745	22	2	.35
38284.0	298.830 7	327.714 5	38.939 1	.13199 2	.55866 2	12.428398 8	.76E-3 2	6.832690	18	2	.36
38285.0	303.792 9	323.875 3	38.942 1	.13212 2	.98795 2	12.429953 7	.75E-3 1	6.831078	18	2	.43
38286.0	308.80 1	320.024 5	38.942 2	.13207 6	.41864 4	12.43152 6	.96E-3 3	6.830854	21	2	.69
38287.0	313.78 1	316.180 5	38.944 2	.13215 6	.85129 3	12.43397 3	.148E-2 2	6.829377	17	2	.49
38288.C	318.85 1	312.320 5	38.942 2	.13215 5	.28660 3	12.43616 3	.133E-2 2	6.828309	14	2	.45
38289.0	323.84 2	308.488 6	38.940 2	.1318 2	.7248 1	12.43932 8	.142E-2 2	6.829905	20	2	.40
38290.C	328.87 1	304.622 5	38.941 2	.13214 3	.16550 3	12.44230 1	.142E-2 2	6.826404	24	2	.43
38291.0	333.879 8	300.756 5	38.944 2	.13216 2	.60920 2	12.44496 2	.138E-2 2	6.825290	22	2	.33
38292.0	338.92 1	296.896 6	38.941 2	.13209 4	.05549 2	12.44789 3	.159E-2 2	6.824760	21	2	.33
38293.0	344.14 7	293.064 1	38.928 5	.13254 2	.5041 3	12.45112 3	.165E-2 2	6.820033	17	2	.41
38294.0	349.2 1	289.21 2	38.923 9	.1322 3	.9569 5	12.45490 8	.230E-2 4	6.821405	16	2	.70
38295.0	354.2 3	285.33 2	38.93 1	.1327 6	.414 1	12.46050 7	.319E-2 5	6.815385	13	2	.85
38296.0	359.1 1	281.43 2	38.95 1	.1318 3	.8786 6	12.4673 2	.25E-2 2	6.820008	10	2	.45
38297.0	4.3 2	277.57 3	38.94 2	.1318	.3464 9	12.47020 9	.175E-2 3	6.818983	12	4	.80
38298.0	9.1 3	273.70 3	38.93 3	.1316	.819 1	12.47353 5	.173E-2 2	6.818891	10	4	.94
38299.C	14.1 2	269.81 3	38.94 3	.1318 8	.2945 9	12.4770 2	.152E-2 5	6.816628	6	2	.39
38300.0	19.11 3	265.924 5	38.947 6	.1315 2	.7732 1	12.48004 5	.171E-2 4	6.817415	16	2	.54
38301.0	24.19 2	262.044 5	38.946 6	.13182 5	.25483 3	12.48363 6	.176E-2 3	6.813851	18	2	.60
38302.0	29.23 3	258.163 7	38.950 1	.13170 1	.7402 1	12.48664 4	.143E-2 3	6.813580	15	2	.47

Table 6

## RELATIVE POSITIONS OF THE SUN AND THE PERIGEE OF SATELLITE 1961 DELTA 1

MJD	Z	$\varphi$	$\psi$	D.R.A.	$\dot{P}$
PERIGEE IN SUNLIGHT					
38211.	515.	-34.1	102.5	89.7	-0.394E-05
38212.	514.	-32.3	102.4	90.4	-0.328E-05
38213.	513.	-30.2	102.0	90.8	-0.276E-05
38214.	511.	-28.0	101.4	91.0	-0.333E-05
38215.	509.	-25.6	100.5	91.0	-0.455E-05
38216.	508.	-23.0	99.4	90.8	-0.472E-05
38217.	507.	-20.3	98.1	90.4	-0.426E-05
38218.	505.	-17.5	96.6	89.9	-0.420E-05
38219.	504.	-14.6	94.9	89.3	-0.420E-05
38220.	502.	-11.6	93.0	88.5	-0.400E-05
38221.	501.	-8.6	91.1	87.7	-0.413E-05
38222.	500.	-5.6	89.1	86.7	-0.397E-05
38223.	499.	-2.5	87.0	85.8	-0.355E-05
38224.	498.	0.6	85.0	84.8	-0.381E-05
38225.	497.	3.7	83.0	83.9	-0.384E-05
38226.	496.	6.8	81.0	83.0	-0.429E-05
38227.	495.	9.9	79.1	82.1	-0.628E-05
38228.	495.	12.9	77.4	81.3	-0.700E-05
38229.	495.	15.8	75.8	80.6	-0.638E-05
38230.	495.	18.7	74.5	80.0	-0.537E-05
38231.	494.	21.4	73.3	79.6	-0.528E-05
38232.	493.	24.1	72.4	79.3	-0.761E-05
38233.	493.	26.6	71.8	79.2	-0.668E-05
38234.	493.	28.9	71.4	79.3	-0.785E-05

Table 6 (cont.)

## RELATIVE POSITIONS OF THE SUN AND THE PERIGEE OF SATELLITE 1961 DELTA 1

MJD	Z	$\phi$	$\psi$	D. R. A.	$\dot{P}$
38235.	493.	31.1	71.3	79.7	-0.733E-05
38236.	493.	33.1	71.5	80.2	-0.680E-05
38237.	492.	34.8	71.9	81.0	-0.641E-05
38238.	492.	36.2	72.6	82.0	-0.628E-05
38239.	491.	37.4	73.4	83.2	-0.523E-05
38240.	491.	38.2	74.4	84.6	-0.706E-05
38241.	490.	38.7	75.6	86.1	-0.967E-05
38242.	489.	38.9	76.9	87.7	-0.928E-05
38243.	488.	38.8	78.2	89.2	-0.875E-05
38244.	487.	38.3	79.7	90.7	-0.784E-05
38245.	487.	37.4	81.1	92.1	-0.784E-05
38246.	485.	36.3	82.5	93.3	-0.823E-05
38247.	484.	34.9	83.9	94.4	-0.809E-05
38248.	483.	33.2	85.2	95.2	-0.770E-05
38249.	482.	31.2	86.4	95.8	-0.731E-05
38250.	480.	29.1	87.4	96.2	-0.679E-05
38251.	479.	26.7	88.4	96.3	-0.705E-05
38252.	481.	24.3	89.2	96.2	-0.770E-05
38253.	477.	21.6	89.9	96.1	-0.587E-05
38254.	475.	18.8	90.4	95.7	-0.561E-05
38255.	474.	15.9	90.8	95.2	-0.613E-05
38256.	474.	13.0	91.1	94.5	-0.535E-05
38257.	473.	10.0	91.2	93.8	-0.639E-05
38258.	473.	7.0	91.2	92.9	-0.769E-05
38259.	476.	4.0	91.0	92.0	-0.834E-05

Table 6 (cont.)

## RELATIVE POSITIONS OF THE SUN AND THE PERIGEE OF SATELLITE 1961 DELTA 1

MJD	Z	$\phi$	$\psi$	D. R.A.	$\dot{P}$
38260.	472.	0.8	91.0	91.2	-0.111E-04
38261.	473.	-2.4	90.8	90.3	-0.109E-04
38262.	470.	-5.6	90.8	89.6	-0.137E-04
38263.	471.	-8.6	90.6	88.7	-0.118E-04
38264.	470.	-11.7	90.4	88.0	-0.108E-04
38265.	470.	-14.6	90.3	87.3	-0.127E-04
38266.	471.	-17.6	90.3	86.8	-0.118E-04
38267.	469.	-20.4	90.4	86.4	-0.123E-04
38268.	470.	-23.1	90.5	86.1	-0.103E-04
38269.	470.	-25.7	90.9	86.1	-0.118E-04
38270.	470.	-28.2	91.3	86.2	-0.123E-04
38271.	470.	-30.5	91.8	86.6	-0.935E-05
38272.	471.	-32.5	92.5	87.2	-0.974E-05
38273.	471.	-34.3	93.3	88.1	-0.973E-05
38274.	470.	-35.9	94.1	89.1	-0.856E-05
38275.	471.	-37.1	95.1	90.4	-0.817E-05
38276.	469.	-38.1	96.1	91.9	-0.791E-05
38277.	468.	-38.7	97.2	93.5	-0.791E-05
38278.	468.	-38.9	98.3	95.1	-0.856E-05
38279.	467.	-38.8	99.4	96.9	-0.804E-05
38280.	466.	-38.4	100.4	98.5	-0.765E-05
38281.	465.	-37.6	101.4	100.0	-0.959E-05
38282.	465.	-36.5	102.2	101.3	-0.920E-05
38283.	462.	-35.1	103.1	102.6	-0.881E-05
38284.	461.	-33.4	103.8	103.6	-0.984E-05

Table 6 (cont.)

## RELATIVE POSITIONS OF THE SUN AND THE PERIGEE OF SATELLITE 1961 DELTA 1

MJD	Z	$\varphi$	$\psi$	D. R.A.	$\dot{P}$
38285.	459.	-31.5	104.3	104.2	-0.971E-05
38286.	458.	-29.3	104.7	104.7	-0.124E-04
38287.	455.	-27.0	104.9	105.0	-0.191E-04
38288.	454.	-24.4	105.0	105.1	-0.172E-04
38289.	454.	-21.8	104.8	104.9	-0.184E-04
38290.	450.	-19.0	104.6	104.6	-0.183E-04
38291.	449.	-16.1	104.1	104.2	-0.178E-04
38292.	447.	-13.1	103.6	103.6	-0.205E-04
38293.	442.	-9.9	103.1	103.1	-0.213E-04
38294.	443.	-6.8	102.3	102.3	-0.297E-04
38295.	437.	-3.6	101.5	101.5	-0.411E-04
38296.	442.	-0.6	100.5	100.5	-0.322E-04
38297.	441.	2.7	99.8	99.8	-0.225E-04
38298.	441.	5.7	98.8	98.8	-0.222E-04
38299.	439.	8.8	98.1	98.0	-0.195E-04
38300.	440.	11.9	97.4	97.2	-0.220E-04
38301.	437.	14.9	96.9	96.6	-0.226E-04
38302.	437.	17.9	96.5	96.1	-0.183E-04

## I. SAO smoothed elements

The following elements are based on 132 observations and are valid for the period July 1 through August 1, 1963.

$$T_0 = 38226.0 \text{ MJD}$$

$$\omega = (181^\circ 169 \pm 5) + (1^\circ 9885 \pm 5)t + .240 \times 10^{-4} t^2 + .1139 \cos \omega$$

$$\Omega = (234^\circ 662 \pm 2) - (1^\circ 8587 \pm 2)t + .48 \times 10^{-5} t^2 + .0145 \cos \omega$$

$$i = (44^\circ 795 \pm 1) + .34 \times 10^{-5} t - .0077 \sin \omega$$

$$e = (.24234 \pm 2) - .710 \times 10^{-5} t + .0005181 \sin \omega$$

$$M = (.43709 \pm 2) + (9.126176 \pm 2)t - (.13 \pm 3) \times 10^{-6} t^2 \\ - (.66 \pm 37) \times 10^{-8} t^3 - .0003162 \cos \omega$$

Standard error of one observation:  $\sigma = \pm 1.18$ .

The following elements are based on 210 observations and are valid for the period August 1 through September 1, 1963.

$$T_0 = 38256.0 \text{ MJD}$$

$$\omega = (240^\circ 787 \pm 3) + (1^\circ 9832 \pm 3)t + .240 \times 10^{-4} t^2 + .1139 \cos \omega$$

$$\Omega = (178^\circ 894 \pm 1) - (1^\circ 8589 \pm 2)t + .48 \times 10^{-5} t^2 + .0145 \cos \omega$$

$$i = (44^\circ 7979 \pm 7) + .34 \times 10^{-5} t - .0077 \sin \omega$$

$$e = (.24245 \pm 1) - .710 \times 10^{-5} t + .0005181 \sin \omega$$

$$M = (.222556 \pm 4) + (9.1261875 \pm 6)t - (.33 \pm 2) \times 10^{-6} t^2 \\ - (.10 \pm 2) \times 10^{-7} t^3 - .0003162 \cos \omega$$

Standard error of one observation:  $\sigma = \pm 1.18$ .

The following elements are based on 78 observations and are valid for the period September 1 through October 1, 1963.

$$T_0 = 38288.0 \text{ MJD}$$

$$\omega = (304^\circ 292 \pm 5) + (1^\circ 9839 \pm 6)t + 240 \times 10^{-4}t^2 + 1139 \cos \omega$$

$$\Omega = (119^\circ 407 \pm 3) - (1^\circ 8591 \pm 3)t + 48 \times 10^{-5}t^2 + 0145 \cos \omega$$

$$i = (44^\circ 799 \pm 1) + 34 \times 10^{-5}t - 0077 \sin \omega$$

$$e = (.24248 \pm 2) - .710 \times 10^{-5}t + .0005181 \sin \omega$$

$$M = (.259993 \pm 8) + (9.126154 \pm 1)t - (.55 \pm 2) \times 10^{-6}t^2 \\ + (.38 \pm 23) \times 10^{-8}t^3 - .0003162 \cos \omega$$

Standard error of one observation:  $\sigma = \pm 1.15$ .

II. SAO mean elements -- Satellite 1962 Alpha Epsilon 1

4 July - 30 September 1963

T (MJD)	$\omega$	$\Omega$	1	e	M	n	$n^{1/2}$	q	N	D	$\sigma$
38214.0	157.30 4	256.92 3	44.77 3	.2440 9	.9235 3	9.12617 1	-.6E-5 5	7.312297	15 6	.69	
38218.0	165.16 2	249.512 8	44.790 5	.2422 1	.42793 9	9.126179 9	-.4E-5 5	7.3229355	14 6	.53	
38222.0	173.11 1	242.086 4	44.791 3	.24233 5	.93265 5	9.126170 4	.1E-5 2	7.328261	25 6	.35	
38226.0	181.07 1	234.655 5	44.800 3	.24214 9	.43728 6	9.126182 4	-.2E-5 2	7.330055	23 6	.46	
38230.0	189.03 1	227.217 5	44.798 3	.2422 1	.94203 6	9.126190 3	.1E-5 2	7.329428	20 6	.37	
38234.0	196.982 6	219.783 4	44.797 2	.24209 5	.44676 2	9.126179 3	-.3E-5 2	7.330579	30 6	.41	
38238.0	204.935 5	212.344 3	44.800 2	.24206 3	.95145 1	9.126174 2	.5E-5 1	7.330801	39 6	.44	
38242.0	212.901 6	204.910 3	44.799 2	.24207 3	.45615 1	9.126188 2	.3E-5 1	7.330732	42 6	.48	
38246.0	220.851 6	197.477 2	44.797 2	.24200 3	.96093 1	9.126189 1	-.4E-5 1	7.331399	31 6	.43	
38250.0	228.794 4	190.044 2	44.799 2	.24191 2	.465649 7	9.126172 1	-.29E-5 6	7.332296	30 6	.34	
38254.0	236.753 6	182.604 2	44.802 2	.24198 3	.970342 9	9.126179 1	.3E-6 8	7.331650	46 6	.45	
38258.0	244.705 4	175.170 2	44.804 1	.24194 2	.475062 8	9.1261805 9	-.11E-5 6	7.332016	66 6	.46	
38262.0	252.653 4	167.741 2	44.805 1	.24195 2	.979765 8	9.126171 1	-.19E-5 6	7.331888	61 6	.38	
38266.0	260.612 4	160.302 3	44.807 1	.24190 2	.484416 8	9.126166 1	.11E-5 7	7.332436	47 6	.32	
38270.0	268.57 1	152.86 1	44.806 4	.24188 8	.98908 2	9.126164 5	.1E-5 4	7.332638	18 6	.55	
38274.0	276.52 2	145.43 1	44.807 4	.24194 4	.49371 2	9.126161 2	-.4E-5 9	7.332014	12 6	.47	
38278.0	284.48 2	137.96 2	44.810 4	.24185 5	.99836 2	9.126148 2	.2E-5 2	7.332907	7 6	.32	
38282.0	292.43 1	130.559 9	44.804 5	.24205 4	.50293 2	9.126153 7	-.1E-5 4	7.330948	10 6	.49	
38286.0	300.38 2	123.134 7	44.806 4	.24203 4	.00752 2	9.126142 3	-.1E-5 2	7.331122	15 6	.52	
38290.0	308.34 2	115.699 3	44.802 4	.24208 7	.51210 2	9.126146 1	-.2E-5 1	7.330705	22 6	.47	
38294.0	316.28 1	108.261 3	44.804 2	.24209 4	.01667 1	9.1261323 9	-.4E-6 7	7.330615	21 6	.33	
38298.0	324.23 1	100.832 4	44.804 2	.24210 4	.52120 2	9.126136 2	.4E-5 1	7.330497	21 6	.39	
38302.0	332.30 8	93.37 1	44.810 9	.24228 8	.0256 1	9.126142 3	.5E-5 2	7.328731	15 6	1.03	

Table 7  
RELATIVE POSITIONS OF THE SUN AND THE PERIGEE OF SATELLITE 1962 ALPHA EPSILON 1

MJD	Z	$\varphi$	$\psi$	D.R.A.	$\dot{P}$
PERIGEE IN SUNLIGHT					
38214.	935.	15.8	40.1	318.1	0.144E-06
38218.	952.	10.4	47.0	312.4	0.961E-07
38222.	950.	4.8	54.3	306.7	-0.240E-07
38226.	952.	-0.8	61.8	300.8	0.480E-07
38230.	951.	-6.3	69.3	295.0	-0.240E-07
38234.	953.	-11.9	76.4	289.4	0.720E-07
38238.	954.	-17.3	83.0	284.0	-0.120E-06
38242.	955.	-22.5	88.9	279.1	-0.720E-07
38246.	958.	-27.4	93.9	274.7	0.961E-07
38250.	960.	-32.0	97.7	270.9	0.696E-07
38254.	961.	-36.1	100.4	267.9	-0.720E-08
38258.	962.	-39.6	101.9	265.8	0.264E-07
38262.	963.	-42.3	102.3	264.5	0.456E-07
38266.	964.	-44.0	101.9	264.1	-0.264E-07
38270.	965.	-44.8	101.0	264.1	-0.240E-07
38274.	964.	-44.4	99.9	264.1	0.961E-07
38278.	965.	-43.0	99.1	263.9	-0.480E-07
38282.	962.	-40.6	98.7	263.1	0.240E-07
38286.	961.	-37.4	99.1	261.5	0.240E-07
38290.	959.	-33.6	100.4	259.0	0.480E-07
38294.	957.	-29.1	102.8	255.7	0.961E-08
38298.	956.	-24.3	106.2	251.7	-0.961E-07
38302.	953.	-19.1	110.5	247.3	-0.120E-06

## I. SAO smoothed elements

The following elements are based on 226 observations and are valid for the period July 1 through August 1, 1963.

$$T_0 = 38226.0 \text{ MJD}$$

$$\omega = (250^\circ.95 \pm 9) + (2^\circ.943 \pm 8)t + 6^\circ.4440 \cos \omega$$

$$\Omega = (204^\circ.4487 \pm 8) - (3^\circ.6090 \pm 1)t + .00083 \cos \omega$$

$$i = (50^\circ.1413 \pm 6) - .0002 \sin \omega$$

$$e = (.007116 \pm 6) + (.14 \pm 9) \times 10^{-5}t + .0007539 \sin \omega$$

$$M = (.9653 \pm 2) + (13.34488 \pm 2)t - (.49 \pm 2) \times 10^{-6}t^2$$

$$- .016432 \cos \omega$$

Standard error of one observation:  $\sigma = \pm 1^\circ.40$ .

The following elements are based on 269 observations and are valid for the period August 1 through September 1, 1963.

$$T_0 = 38256.0 \text{ MJD}$$

$$\omega = (340^\circ.31 \pm 6) + (2^\circ.911 \pm 6)t + 6^\circ.4440 \cos \omega$$

$$\Omega = (96^\circ.1810 \pm 6) - (3^\circ.60895 \pm 7)t + .00083 \cos \omega$$

$$i = (50^\circ.1437 \pm 5) - .0002 \sin \omega$$

$$e = (.007095 \pm 8) + (.66 \pm 9) \times 10^{-5}t + .0007539 \sin \omega$$

$$M = (.3088 \pm 2) + (13.34501 \pm 2)t + (.185 \pm 1) \times 10^{-5}t^2$$

$$- .016432 \cos \omega$$

Standard error of one observation:  $\sigma = \pm 1^\circ.08$ .

The following elements are based on 340 observations and are valid for the period September 1 through October 1, 1963.

$$T_0 = 38287.0 \text{ MJD}$$

$$\omega = (71^\circ 74 \pm 5) + (3^\circ 032 \pm 7)t + 6^\circ 4440 \cos \omega$$

$$\Omega = (344^\circ 2985 \pm 7) - (3^\circ 60887 \pm 8)t + 0^\circ 00083 \cos \omega$$

$$i = (50^\circ 1435 \pm 5) - 0^\circ 0002 \sin \omega$$

$$e = (.007109 \pm 9) + (.07 \pm 10) \times 10^{-5}t + .0007539 \sin \omega$$

$$M = (.0024 \pm 1) + (13.34477 \pm 2)t + (.33 \pm 2) \times 10^{-6}t^2$$

$$- .016432 \cos \omega$$

Standard error of one observation:  $\sigma = \pm 1^\circ 60$ .

## II. SAO mean elements -- Satellite 1962 Beta Mu 1

4 July - 30 September 1

T (MD)	$\omega$	$\Omega$	I	e	M	n	$n'/2$	q	N	D	$\sigma$
38214.0	209.8 3	247.760 3	50.143 1	.00663 2	.8416 8	13.344934 4	-.1E-5 3	7.457997	20	4	.35
38218.0	222.2 3	233.322 2	50.140 2	.00652 2	.2197 7	13.344923 3	-.7E-5 2	7.458763	39	4	.55
38222.0	235.3 2	218.885 2	50.140 2	.00645 1	.5959 6	13.344916 2	-.4E-5 2	7.459346	39	4	.50
38226.0	248.8 3	204.443 2	50.140 1	.00638 1	.9709 7	13.344911 2	.3E-5 2	7.459841	40	4	.47
38230.0	262.1 2	190.012 2	50.140 2	.00632 2	.3465 5	13.344914 1	.1E-5 1	7.460294	54	4	.50
38234.0	275.0 2	175.580 3	50.140 2	.00633 3	.7230 6	13.344907 3	.1E-5 3	7.460193	40	4	.60
38238.0	288.7 1	161.138 2	50.142 1	.00634 2	.0975 4	13.344916 2	-.1E-5 2	7.460177	23	4	.37
38242.0	303.0 2	146.702 4	50.143 3	.00624 4	.4700 7	13.344920 3	.3E-5 4	7.460888	33	4	.76
38246.0	317.8 6	132.28 1	50.136 8	.00617 6	.84139 2	13.344936 3	-.1E-5 9	7.461335	49	6	1.67
38250.0	328.9 4	117.834 8	50.146 8	.00658 4	.223 1	13.344937 6	.40E-4 5	7.458359	45	4	1.13
38254.0	341.2 3	103.397 6	50.149 8	.00672 3	.6014 9	13.344933 4	.27E-4 3	7.457304	31	4	.63
38258.0	352.30 9	88.967 1	50.147 1	.00691 1	.9830 3	13.344969 2	.7E-5 1	7.455824	51	4	.38
38262.0	4.16 7	74.529 1	50.142 1	.00713 2	.3626 2	13.344977 2	.5E-5 2	7.454180	71	4	.57
38266.0	15.76 9	60.092 2	50.144 2	.00728 3	.7428 3	13.345007 3	.9E-5 3	7.453047	22	4	.43
38270.0	27.11 7	45.656 1	50.145 1	.00746 2	.1238 2	13.345016 1	.3E-5 1	7.451694	54	4	.51
38274.0	37.9 2	31.217 7	50.139 9	.00752 2	.506 4	13.34504 1	.1E-4 3	7.451279	18	4	.99
38278.0	45.1 2	16.777 2	50.142 2	.00763 3	.8876 5	13.345044 3	-.1E-5 3	7.450430	44	4	.61
38282.0	60.2 1	2.343 1	50.145 1	.00774 2	.2693 4	13.345053 3	.4E-5 2	7.449579	46	4	.52
38286.0	71.2 1	347.913 2	50.143 2	.00778 3	.6513 3	13.345055 3	.10E-4 4	7.449276	47	4	.75
38290.0	81.90 6	333.473 1	50.144 1	.00786 2	.0340 2	13.345066 2	.5E-5 2	7.448720	76	4	.54
38294.0	92.56 8	319.038 2	50.143 1	.00784 2	.4168 2	13.345060 2	.3E-5 2	7.448872	52	4	.51
38298.0	103.5 1	304.600 2	50.139 1	.00789 2	.7989 3	13.345055 3	-.4E-5 2	7.448887	42	4	.48
38302.0	114.3 2	290.166 2	50.140 2	.00783 2	.1814 5	13.345056 3	.1E-5 2	7.448933	42	4	.66

Table 8

RELATIVE POSITIONS OF THE SUN AND THE PERIGEE OF SATELLITE 1962 BETA MU 1

MJD	Z	$\varphi$	$\psi$	D. R.A.	$\dot{P}$
PERIGEE IN SUNLIGHT					
38214.	1083.	-22.4	47.5	345.6	0.112E-07
38218.	1086.	-31.0	58.0	337.1	0.786E-07
38222.	1090.	-39.1	66.9	331.1	0.449E-07
38226.	1092.	-45.7	73.0	328.7	-0.337E-07
38230.	1094.	-49.5	75.5	329.2	-0.112E-07
38234.	1094.	-49.9	74.6	330.8	-0.112E-07
38238.	1093.	-46.6	70.4	332.4	0.112E-07
38242.	1091.	-40.1	64.0	331.6	-0.337E-07
38246.	1089.	-31.0	57.3	327.8	0.112E-07
38250.	1083.	-23.4	56.6	318.5	-0.449E-06
38254.	1080.	-14.3	58.2	309.1	-0.303E-06
38258.	1078.	-5.9	64.3	298.3	-0.786E-07
38262.	1076.	3.2	72.0	287.8	-0.562E-07
38266.	1076.	12.0	80.8	277.2	-0.101E-06
38270.	1076.	20.5	89.4	267.0	-0.337E-07
38274.	1078.	28.1	97.1	257.3	-0.112E-06
38278.	1079.	35.5	102.6	249.2	0.112E-07
38282.	1081.	41.8	106.1	242.9	-0.449E-07
38286.	1082.	46.6	108.0	238.7	-0.112E-06
38290.	1083.	49.5	109.4	236.1	-0.562E-07
38294.	1083.	50.1	111.3	234.6	-0.337E-07
38298.	1082.	48.3	114.2	233.1	0.449E-07
38302.	1081.	44.4	119.4	229.7	-0.112E-07

## I. SAO smoothed elements

The following elements are based on 90 observations and are valid for the period July 1 through July 16, 1963.

$$T_0 = 38218.0 \text{ MJD}$$

$$\omega = (282^\circ 091 \pm 7) - (1^\circ 117 \pm 1)t - .26 \times 10^{-6} t^2 + .2390 \cos \omega$$

$$\Omega = (227^\circ 077 \pm 1) - (1^\circ 7108 \pm 3)t - .60 \times 10^{-4} t^2 + .0323 \cos \omega$$

$$i = (70^\circ 365 \pm 2) - .0023 \sin \omega$$

$$e = (.15555 \pm 6) - (.01 \pm 12) \times 10^{-4} t - .701 \times 10^{-7} t^2 + .0007061 \sin \omega$$

$$M = (.17539 \pm 2) + (12.518819 \pm 5)t + (.0001916 \pm 4)t^2 - (.96 \pm 5) \times 10^{-6} t^3 \\ - (.191 \pm 8) \times 10^{-6} t^4 - .0006368 \cos \omega$$

Standard error of one observation:  $\sigma = \pm 1^\circ 83$ .

The following elements are based on 123 observations and are valid for the period July 16 through August 1, 1963.

$$T_0 = 38234.0 \text{ MJD}$$

$$\omega = (264^\circ 305 \pm 4) - (1^\circ 1137 \pm 9)t - .26 \times 10^{-6} t^2 + .2390 \cos \omega$$

$$\Omega = (199^\circ 695 \pm 1) - (1^\circ 7120 \pm 2)t - .601 \times 10^{-4} t^2 + .0323 \cos \omega$$

$$i = (70^\circ 361 \pm 1) - .0023 \sin \omega$$

$$e = (.15526 \pm 1) - (.14 \pm 3) \times 10^{-4} t - .701 \times 10^{-7} t^2 + .0007061 \sin \omega$$

$$M = (.51883 \pm 1) + (12.524150 \pm 2)t + (.0001716 \pm 4)t^2 - (.80 \pm 3) \times 10^{-6} t^3 \\ - (.77 \pm 6) \times 10^{-7} t^4 - .0006368 \cos \omega$$

Standard error of one observation:  $\sigma = \pm 1^\circ 43$ .

The following elements are based on 60 observations and are valid for the period August 1 through August 16, 1963.

$$T_0 = 38250.0 \text{ MJD}$$

$$\omega = (246^\circ 495 \pm 9) - (1^\circ 112 \pm 2)t - .26 \times 10^{-6} t^2 + .2390 \cos \omega$$

$$\Omega = (172^\circ 290 \pm 4) - (1^\circ 7133 \pm 3)t - .601 \times 10^{-4} t^2 + .0323 \cos \omega$$

$$i = (70^\circ 358 \pm 5) - .0023 \sin \omega$$

$$e = (.1549 \pm 2) + (.03 \pm 35) \times 10^{-4} t - .701 \times 10^{-7} t^2 + .0007061 \sin \omega$$

$$M = (.94767 \pm 6) + (12.52942 \pm 1)t + (.0001431 \pm 4)t^2 - (.184 \pm 4) \times 10^{-5} t^3 \\ - (.14 \pm 8) \times 10^{-7} t^4 - .0006368 \cos \omega$$

Standard error of one observation:  $\sigma = \pm 1.18$ .

The following elements are based on 52 observations and are valid for the period August 16 through September 1, 1963.

$$T_0 = 38265.0 \text{ MJD}$$

$$\omega = (229^\circ 81 \pm 4) - (1^\circ 100 \pm 7)t - .26 \times 10^{-6} t^2 + .2390 \cos \omega$$

$$\Omega = (146^\circ 58 \pm 2) - (1^\circ 7144 \pm 6)t - .601 \times 10^{-4} t^2 + .0323 \cos \omega$$

$$i = (70^\circ 36 \pm 2) - .0023 \sin \omega$$

$$e = (.1551 \pm 4) + (.65 \pm 55) \times 10^{-4} t - .701 \times 10^{-7} t^2 + .0007061 \sin \omega$$

$$M = (.9214 \pm 1) + (12.53444 \pm 2)t + (.0002262 \pm 9)t^2 + (.16 \pm 7) \times 10^{-6} t^3 \\ + (.26 \pm 13) \times 10^{-7} t^4 - .0006368 \cos \omega$$

Standard error of one observation:  $\sigma = \pm 2.60$ .

The following elements are based on 41 observations and are valid for the period September 1 through September 15, 1963.

$$T_0 = 38280.0 \text{ MJD}$$

$$\omega = (213^\circ 12 \pm 5) - (1^\circ 103 \pm 5)t - .26 \times 10^{-6} t^2 + .2390 \cos \omega$$

$$\Omega = (120^\circ 834 \pm 6) - (1^\circ 7169 \pm 5)t - .601 \times 10^{-4} t^2 + .0323 \cos \omega$$

$$i = (70^\circ 365 \pm 7) - .0023 \sin \omega$$

$$e = (.1547 \pm 2) - (.11 \pm 27) \times 10^{-4} t - .701 \times 10^{-7} t^2 + .0007061 \sin \omega$$

$$M = (.98922 \pm 6) + (12.541201 \pm 9)t + (.0002513 \pm 7)t^2 + (.492 \pm 7) \times 10^{-5} t^3 \\ + (.11 \pm 2) \times 10^{-6} t^4 - .0006368 \cos \omega$$

Standard error of one observation:  $\sigma = \pm 1.98$ .

The following elements are based on 45 observations and are valid for the period September 15 through October 1, 1963.

$$T_0 = 38295.0 \text{ MJD}$$

$$\omega = (196^\circ 37 \pm 3) - (1^\circ 132 \pm 6)t - .26 \times 10^{-4} t^2 + .2390 \cos \omega$$

$$\Omega = (95^\circ 044 \pm 8) - (1^\circ 7202 \pm 9)t - .601 \times 10^{-4} t^2 + .0323 \cos \omega$$

$$i = (70^\circ 37 \pm 1) - .0023 \sin \omega$$

$$e = (.15386 \pm 8) - (.54 \pm 12) \times 10^{-4} t - .701 \times 10^{-7} t^2 + .0007061 \sin \omega$$

$$M = (.19074 \pm 9) + (12.55451 \pm 3)t + (.000633 \pm 3)t^2 + (.18 \pm 3) \times 10^{-5} t^3 \\ - (.61 \pm 5) \times 10^{-6} t^4 - .0006368 \cos \omega$$

Standard error of one observation:  $\sigma = \pm 4.23$ .

## II. SAO mean elements -- Satellite 1962 Beta Tau 2

2 July - 31 August 1963

$T$ (MJD)	$\omega$	$\Omega$	$i$	$e$	$M$	$n$	$n'/2$	$q$	$N$	$D$	$\sigma$
38212.0	288.868 5	237.350 2	70.369 2	.15490 2	.06912 1	12.516617 1	-1643E-3 8	6.622815	70	6	.34
38214.0	286.641 5	233.928 1	70.368 2	.15487 2	.10300 1	12.517283 1	.170E-3 1	6.622814	61	6	.36
38216.0	284.400 5	230.506 1	70.366 2	.15487 2	.13828 1	12.518044 2	.202E-3 1	6.622528	57	6	.38
38218.0	282.174 6	227.081 1	70.362 1	.15481 2	.17517 2	12.518827 1	.1896E-3 7	6.622756	49	6	.40
38220.0	279.921 4	223.661 1	70.362 1	.15478 1	.21365 1	12.519564 1	.1755E-3 6	6.622723	59	6	.39
38222.0	277.680 5	220.240 1	70.367 2	.15473 2	.25352 1	12.520231 2	.153E-3 1	6.622925	62	6	.43
38224.0	275.456 3	216.8169 8	70.364 1	.15469 8	.294562 8	12.520808 1	.1397E-3 5	6.622961	78	6	.35
38226.0	273.219 6	213.391 2	70.364 2	.15470 1	.33672 2	12.521401 2	.164E-3 1	6.622675	65	6	.49
38228.0	270.980 5	209.966 2	70.361 2	.15466 1	.38018 1	12.522086 2	.184E-3 1	6.622772	70	6	.46
38230.0	268.772 5	206.544 2	70.357 2	.15461 1	.42499 2	12.522779 2	.166E-3 1	6.622946	57	6	.45
38232.0	266.528 5	203.116 1	70.357 2	.15457 1	.47124 1	12.523461 2	.172E-3 1	6.623028	66	6	.48
38234.0	264.290 4	199.691 1	70.362 1	.15452 1	.51885 1	12.524152 1	.1751E-3 8	6.623168	71	6	.48
38236.0	262.044 4	196.2656 9	70.363 1	.15446 1	.567881 9	12.524832 1	.1662E-3 7	6.623374	77	6	.44
38238.0	259.818 4	192.8401 8	70.366 1	.15449 1	.618197 9	12.525461 2	.1501E-3 9	6.622964	79	6	.46
38240.0	257.628 5	189.413 1	70.364 1	.15449 1	.66975 1	12.526065 2	.150E-3 1	6.622730	62	6	.47
38242.0	255.351 7	185.986 1	70.362 2	.15446 2	.72255 2	12.526802 1	.187E-3 1	6.622659	62	6	.48
38244.0	253.104 6	182.559 2	70.359 2	.15443 1	.77694 2	12.527517 2	.1688E-3 9	6.622705	53	6	.37
38246.0	250.876 6	179.131 1	70.360 2	.15441 1	.83264 2	12.528188 2	.166E-3 1	6.622592	52	6	.35
38248.0	248.644 4	175.701 1	70.362 1	.15442 2	.88967 1	12.528835 1	.162E-3 1	6.622287	54	6	.32
38250.0	246.395 5	172.273 1	70.362 1	.15439 2	.94801 1	12.529427 2	.139E-3 1	6.622293	54	6	.29
38252.0	244.150 5	168.842 1	70.363 1	.15437 2	.00747 2	12.529964 2	.126E-3 1	6.622283	50	6	.28
38254.0	241.942 9	165.417 2	70.362 2	.15428 2	.06779 3	12.530462 1	.1239E-3 9	6.622807	42	6	.21
38256.0	239.70 1	161.989 3	70.361 3	.15436 2	.12925 4	12.530939 3	.121E-3 2	6.622010	47	6	.42
38258.0	237.474 9	158.563 2	70.359 3	.15442 2	.19156 2	12.531463 3	.157E-3 2	6.621396	48	6	.42
38260.0	235.21 1	155.132 3	70.360 3	.15440 2	.25522 3	12.532182 2	.190E-3 1	6.621274	49	6	.55
38262.0	232.988 9	151.703 3	70.363 3	.15440 3	.32033 3	12.533098 2	.244E-3 1	6.620915	49	6	.43
38264.0	230.77 1	148.271 3	70.364 3	.15433 2	.38745 3	12.534053 3	.223E-3 2	6.621119	42	6	.37
38266.0	228.54 1	144.839 3	70.362 3	.15430 2	.45645 4	12.534938 4	.224E-3 2	6.621070	32	6	.33
38268.0	226.29 1	141.407 3	70.364 3	.15422 2	.52724 4	12.535824 3	.221E-3 2	6.621429	28	6	.35
38270.0	224.06 1	137.979 3	70.364 3	.15425 2	.59971 3	12.536736 5	.239E-3 2	6.620820	33	6	.38
38272.0	221.837 8	134.548 3	70.358 3	.15425 2	.67413 2	12.537700 2	.235E-3 1	6.620482	40	6	.36

## II. SAO mean elements -- Satellite 1962 Beta Tau 2

2-30 September 1963

T (MJD)	$\omega$	$\Omega$	i	e	M	n	$n'/2$	q	N	D	c
38274.0	219.619 9	131.114 3	70.359 3	.15419 2	.75042 3	12.538612 3	.221E-3 2	6.620615	37	6	.37
38276.0	217.388 9	127.681 3	70.362 3	.15420 2	.82848 3	12.539456 1	.210E-3 1	6.620262	39	6	.39
38278.0	215.152 6	124.245 2	70.366 3	.15420 1	.90823 2	12.540319 2	.2247E-3 8	6.619991	43	6	.33
38280.0	212.894 5	120.811 2	70.364 3	.15418 1	.98982 1	12.541266 1	.2475E-3 6	6.619808	39	6	.32
38282.0	210.67 1	117.370 4	70.368 5	.15415 3	.07326 2	12.542319 2	.290E-3 1	6.619684	39	6	.60
38284.0	208.45 1	113.942 4	70.361 6	.15412 3	.15901 3	12.543545 2	.319E-3 2	6.619429	30	6	.66
38286.0	206.31 3	110.51 1	70.36 1	.15434 6	.24721 6	12.544903 8	.361E-3 5	6.617282	31	6	1.80
38288.0	204.001 9	107.070 3	70.357 5	.15407 2	.33876 2	12.546709 4	.486E-3 2	6.618748	24	6	.48
38290.0	201.76 1	103.630 4	70.360 5	.15402 2	.43416 3	12.548704 3	.501E-3 2	6.618396	21	6	.47
38292.0	199.49 3	100.185 4	70.368 5	.15394 6	.53366 9	12.550784 6	.548E-3 4	6.618345	14	6	.67
38294.0	197.43 4	96.744 8	70.36 1	.1537 1	.63685 7	12.55313 1	.64E-3 1	6.619468	17	6	1.61
38296.0	195.11 2	93.304 7	70.353 9	.15363 9	.74596 6	12.55581 1	.662E-3 8	6.618974	16	6	1.43
38298.0	192.81 1	89.858 3	70.361 5	.15361 4	.86048 2	12.558251 5	.568E-3 3	6.618259	20	6	.57
38300.0	190.587 6	86.414 2	70.360 3	.15352 2	.97921 2	12.560507 3	.567E-3 2	6.618179	29	6	.42
38302.0	188.40 5	82.972 3	70.356 6	.15359 6	.1023 2	12.562731 5	.543E-3 3	6.616874	30	6	.72

Table 9  
RELATIVE POSITIONS OF THE SUN AND THE PERIGEE OF SATELLITE 1962 BETA TAU 2

MJD	Z	$\phi$	$\psi$	D.R.A.	$\dot{P}$
PERIGEE IN EARTH SHADOW					
38212.	261.	-63.0	111.6	92.6	-0.210E-05
38214.	262.	-64.5	107.8	83.3	-0.217E-05
PERIGEE IN SUNLIGHT					
38216.	262.	-65.8	104.2	73.5	-0.258E-05
38218.	263.	-67.0	101.1	63.3	-0.242E-05
38220.	263.	-68.1	98.3	52.7	-0.224E-05
38222.	263.	-69.0	95.9	41.6	-0.195E-05
38224.	263.	-69.6	94.0	30.1	-0.178E-05
38226.	263.	-70.1	92.6	18.3	-0.209E-05
38228.	263.	-70.3	91.6	6.3	-0.235E-05
38230.	264.	-70.3	91.3	354.3	-0.212E-05
38232.	264.	-70.1	91.4	342.3	-0.219E-05
38234.	264.	-69.6	92.1	330.5	-0.223E-05
38236.	264.	-68.9	93.3	319.1	-0.212E-05
38238.	263.	-68.0	94.9	308.2	-0.191E-05
38240.	263.	-66.9	97.0	297.8	-0.191E-05
38242.	262.	-65.7	99.6	287.6	-0.238E-05
38244.	262.	-64.3	102.5	278.0	-0.215E-05
PERIGEE IN EARTH SHADOW					
38246.	261.	-62.9	105.8	268.9	-0.212E-05
38248.	260.	-61.3	109.3	260.1	-0.206E-05
38250.	260.	-59.7	113.1	251.7	-0.177E-05
38252.	259.	-58.0	117.1	243.5	-0.161E-05
38254.	259.	-56.2	121.2	235.7	-0.158E-05
38256.	258.	-54.4	125.3	228.0	-0.154E-05

Table 9 (cont.)

## RELATIVE POSITIONS OF THE SUN AND THE PERIGEE OF SATELLITE 1962 BETA TAU 2

MJD	Z	$\phi$	$\psi$	D.R.A.	P
38258.	257.	-52.6	129.5	220.6	-0.200E-05
38260.	256.	-50.7	133.7	213.4	-0.242E-05
38262.	255.	-48.8	137.6	206.3	-0.311E-05
38264.	254.	-46.9	141.3	199.4	-0.284E-05
38266.	253.	-44.9	144.5	192.5	-0.285E-05
38268.	253.	-42.9	147.1	185.8	-0.281E-05
38270.	252.	-40.9	148.8	179.2	-0.304E-05
38272.	251.	-38.9	149.4	172.7	-0.299E-05
38274.	250.	-36.9	148.7	166.2	-0.281E-05
38276.	249.	-34.9	147.0	159.8	-0.267E-05
38278.	248.	-32.8	144.2	153.5	-0.286E-05
38280.	247.	-30.8	140.6	147.2	-0.315E-05
38282.	246.	-28.7	136.3	141.0	-0.369E-05
38284.	245.	-26.7	131.6	134.8	-0.405E-05
38286.	243.	-24.7	126.5	128.7	-0.459E-05
38288.	244.	-22.5	121.1	122.5	-0.617E-05
38290.	243.	-20.4	115.5	116.4	-0.636E-05
38292.	242.	-18.3	109.7	110.3	-0.696E-05
<b>PERIGEE IN SUNLIGHT</b>					
38294.	243.	-16.4	104.0	104.3	-0.812E-05
38296.	242.	-14.2	98.0	98.3	-0.840E-05
38298.	241.	-12.1	92.0	92.2	-0.720E-05
38300.	240.	-10.0	86.0	86.2	-0.719E-05
38302.	239.	-7.9	80.0	80.2	-0.688E-05

## I. SAO smoothed elements

The following elements are based on 93 observations and are valid for the period July 1 through August 1, 1963.

$$T_0 = 38226.0 \text{ MJD}$$

$$\omega = (77^\circ 045 \pm 7) + (1^\circ 2101 \pm 9)t + .0958 \cos \omega$$

$$\Omega = (304^\circ 713 \pm 2) - (1^\circ 2790 \pm 1)t + .0158 \cos \omega$$

$$i = (47^\circ 515 \pm 2) - .0082 \sin \omega$$

$$e = (.28464 \pm 3) - (.64 \pm 34) \times 10^{-5}t + .0005025 \sin \omega$$

$$M = (.181103 \pm 9) + (7.780926 \pm 1)t - (.36 \pm 2) \times 10^{-6}t^2 \\ - .0002577 \cos \omega$$

Standard error of one observation:  $\sigma = \pm 1.08$ .

The following elements are based on 97 observations and are valid for the period August 1 through September 1, 1963.

$$T_0 = 38256.0 \text{ MJD}$$

$$\omega = (113^\circ 361 \pm 5) + (1^\circ 2119 \pm 5)t + .0958 \cos \omega$$

$$\Omega = (266^\circ 332 \pm 1) - (1^\circ 2790 \pm 2)t + .0158 \cos \omega$$

$$i = (47^\circ 508 \pm 1) - .0082 \sin \omega$$

$$e = (.28445 \pm 2) - (.64 \pm 17) \times 10^{-5}t + .0005025 \sin \omega$$

$$M = (.608601 \pm 7) + (7.7809100 \pm 7)t - (.38 \pm 14) \times 10^{-7}t^2 \\ - .0002577 \cos \omega$$

Standard error of one observation:  $\sigma = \pm 0.98$ .

The following elements are based on 92 observations and are valid for the period September 1 through October 1, 1963.

$$T_0 = 38287.0 \text{ MJD}$$

$$\omega = (150^\circ 965 \pm 9) + (1^\circ 2113 \pm 8)t + .0958 \cos \omega$$

$$\Omega = (226^\circ 674 \pm 2) - (1^\circ 2791 \pm 2)t + .0158 \cos \omega$$

$$i = (47^\circ 510 \pm 1) - .0082 \sin \omega$$

$$e = (.28433 \pm 1) - (.48 \pm 12) \times 10^{-5}t + .0005025 \sin \omega$$

$$M = (.81672 \pm 2) + (7.780906 \pm 1)t - (.84 \pm 21) \times 10^{-7}t^2 \\ - .0002577 \cos \omega$$

Standard error of one observation:  $\sigma = \pm 1^\circ 38.$

## II. SAO mean elements -- Satellite 1962 Beta Upsilon 1

4 July - 30 September 1963

T (MJD)	$\omega$	$\Omega$	$i$	$e$	M	n	$n'/2$	q	N	D	$\sigma$
38214.0	62.552 3	320.077 1	47.510 1	.285033 9	.809814 5	7.780937 1	-.4E-6 6	7.691084	45	6	.18
38218.0	67.383 2	314.958 1	47.510 1	.285022 9	.933574 4	7.7809327 5	.5E-6 3	7.691199	46	6	.16
38222.0	72.215 3	309.637 1	47.508 1	.28504 1	.051329 5	7.7809281 8	-.8E-6 5	7.690971	54	6	.23
38226.0	77.050 3	304.715 2	47.507 1	.28504 2	.181051 6	7.780928 1	.22E-5 7	7.691067	47	6	.24
38230.0	81.888 3	299.600 2	47.506 1	.28503 1	.304767 5	7.7809230 9	-.2E-6 4	7.691171	54	6	.24
38234.0	86.721 4	294.481 2	47.506 1	.28501 1	.428474 6	7.780922 1	.4E-6 7	7.691378	57	6	.27
38238.0	91.554 4	289.366 2	47.507 1	.28503 1	.552175 6	7.780916 1	-.4E-6 6	7.691132	51	6	.25
38242.0	96.390 5	284.240 2	47.503 1	.28500 1	.675859 7	7.780915 1	.6E-6 6	7.691456	43	6	.26
38246.0	101.226 4	279.128 2	47.506 1	.28493 1	.799532 7	7.7809131 9	-.19E-5 6	7.692198	35	6	.20
38250.0	106.054 3	274.010 1	47.5027 9	.284960 8	.923217 5	7.7809131 8	-.2E-6 6	7.691877	43	6	.17
38254.0	111.900 2	268.8903 9	47.5024 7	.284915 6	.046863 4	7.7809118 5	.1E-6 5	7.692365	46	6	.14
38258.0	115.739 2	263.772 1	47.5024 8	.284853 8	.170519 5	7.7809136 6	.17E-5 4	7.693028	50	6	.19
38262.0	120.575 3	258.654 1	47.4978 9	.284842 8	.294205 5	7.7809130 8	-.16E-5 6	7.693153	54	6	.23
38266.0	125.424 3	253.531 1	47.5007 8	.284813 7	.417853 4	7.7809102 5	-.6E-6 4	7.693468	54	6	.19
38270.0	130.271 3	248.415 1	47.5004 8	.284750 6	.541484 4	7.7809114 3	.10E-5 3	7.694140	50	6	.16
38274.0	135.114 4	243.296 2	47.500 1	.28467 1	.665152 6	7.7809174 7	.7E-6 5	7.694972	45	6	.25
38278.0	139.962 3	238.175 1	47.5005 9	.284665 7	.788812 5	7.7809096 5	-.20E-5 3	7.695163	40	6	.17
38282.0	144.804 3	233.056 2	47.4995 8	.284596 7	.912431 5	7.7809080 7	.14E-5 4	7.695799	45	6	.16
38286.0	149.660 4	227.937 2	47.5029 9	.284552 9	.036064 7	7.7809139 8	-.10E-5 5	7.696273	46	6	.20
38290.0	154.503 7	222.821 2	47.506 1	.284528 9	.15970 1	7.780906 1	-.2E-6 6	7.696530	31	6	.23
38294.0	159.37 1	217.705 2	47.513 2	.28327 1	.28327 2	7.780900 1	-.1E-6 7	7.697266	46	6	.42
38298.0	164.219 7	212.582 2	47.513 1	.284399 9	.40688 1	7.7809075 8	.3E-6 5	7.697920	47	6	.30
38302.0	169.066 5	207.470 2	47.511 1	.284382 7	.530499 9	7.780902 1	-.29E-5 8	7.698106	44	6	.23

Table 10

RELATIVE POSITIONS OF THE SUN AND THE PERIGEE OF SATELLITE 1962 BETA UPSILON 1

MJD	Z	$\Phi$	$\Psi$	D. R.A.	$\dot{P}$
PERIGEE IN SUNLIGHT					
38214.	1322.	40.9	75.1	270.2	0.132E-07
38218.	1323.	42.9	77.0	266.9	-0.165E-07
38222.	1323.	44.6	78.8	263.9	0.264E-07
38226.	1324.	45.9	80.4	261.3	-0.727E-07
38230.	1324.	46.9	82.0	259.1	0.661E-08
38234.	1325.	47.4	83.7	257.0	-0.132E-07
38238.	1324.	47.5	85.5	255.1	0.132E-07
38242.	1325.	47.1	87.6	253.2	-0.198E-07
38246.	1325.	46.3	89.9	251.2	0.628E-07
38250.	1324.	45.1	92.7	248.9	0.661E-08
38254.	1324.	43.5	95.9	246.4	-0.330E-08
38258.	1324.	41.6	99.5	243.6	-0.562E-07
38262.	1323.	39.4	103.7	240.4	0.529E-07
38266.	1323.	36.9	108.2	236.9	0.198E-07
38270.	1323.	34.2	113.3	233.1	-0.330E-07
38274.	1322.	31.4	118.7	228.9	-0.231E-07
PERIGEE IN EARTH SHADOW					
38278.	1322.	28.3	124.5	224.5	0.661E-07
38282.	1321.	25.1	130.7	219.9	-0.462E-07
38286.	1321.	21.9	137.1	215.1	0.330E-07
38290.	1320.	18.5	143.8	210.1	0.661E-08
38294.	1320.	15.1	150.7	205.0	0.330E-08
38298.	1320.	11.6	157.7	199.8	-0.991E-08
38302.	1320.	8.0	164.6	194.4	0.958E-07

## I. SAO smoothed elements

The following elements are based on 102 observations and are valid for the period April 3 through April 15, 1963.

$$T_0 = 38129.0 \text{ MJD}$$

$$\omega = (59^\circ 62 \pm 2) + (1^\circ 568 \pm 5)t + .000494t^2 + 1^\circ 6490 \cos \omega$$

$$\Omega = (95^\circ 467 \pm 2) - (3^\circ 9411 \pm 4)t - .000110t^2 + .0205 \cos \omega$$

$$i = (57^\circ 627 \pm 2) - .0021 \sin \omega$$

$$e = (.04724 \pm 1) - .338 \times 10^{-4}t + .0012909 \sin \omega$$

$$M = (.25244 \pm 6) + (14.94067 \pm 2)t + (.0002437 \pm 8)t^2 + (.88 \pm 8) \times 10^{-6}t^3 \\ + (.45 \pm 2) \times 10^{-6}t^4 - .0040105 \cos \omega$$

Standard error of one observation:  $\sigma = \pm 2^\circ 15$ .

The following elements are based on 64 observations and are valid for the period April 15 through May 1, 1963.

$$T_0 = 38142.0 \text{ MJD}$$

$$\omega = (80^\circ 11 \pm 2) + (1^\circ 576 \pm 4)t + .000494t^2 + 1^\circ 6490 \cos \omega$$

$$\Omega = (44^\circ 213 \pm 3) - (3^\circ 9447 \pm 4)t - .000110t^2 + .0205 \cos \omega$$

$$i = (57^\circ 629 \pm 2) - .0021 \sin \omega$$

$$e = (.04692 \pm 2) - .338 \times 10^{-4}t + .0012909 \sin \omega$$

$$M = (.52861 \pm 6) + (14.94806 \pm 1)t + (.0002685 \pm 2)t^2 \\ - (.140 \pm 4) \times 10^{-5}t^3 - .0040105 \cos \omega$$

Standard error of one observation:  $\sigma = \pm 3^\circ 38$ .

The following elements are based on 35 observations and are valid for the period May 1 through May 15, 1963.

$$T_0 = 38158.0 \text{ MJD}$$

$$\omega = (105^\circ 43 \pm 5) + (1^\circ 64 \pm 1)t + .000494t^2 + 1^\circ 6490 \cos \omega$$

$$\Omega = (341^\circ 060 \pm 4) - (3^\circ 9523 \pm 7)t - .000110t^2 + .0205 \cos \omega$$

$$i = (57^\circ 621 \pm 2) - .0021 \sin \omega$$

$$e = (.04656 \pm 1) - .338 \times 10^{-4}t + .0012909 \sin \omega$$

$$M = (.7682 \pm 2) + (14.95732 \pm 3)t + (.000356 \pm 1)t^2 + (.47 \pm 3) \times 10^{-5}t^3 \\ - (.21 \pm 3) \times 10^{-6}t^4 - .0040105 \cos \omega$$

Standard error of one observation:  $\sigma = \pm 1^\circ 45$ .

The following elements are based on 58 observations and are valid for the period May 15 through June 1, 1963.

$$T_0 = 38173.0 \text{ MJD}$$

$$\omega = (129^\circ 60 \pm 4) + (1^\circ 610 \pm 7)t + .000494t^2 + 1^\circ 6490 \cos \omega$$

$$\Omega = (281^\circ 743 \pm 4) - (3^\circ 9566 \pm 5)t - .000110t^2 + .0205 \cos \omega$$

$$i = (57^\circ 625 \pm 5) - .0021 \sin \omega$$

$$e = (.04614 \pm 2) - .338 \times 10^{-4}t + .0012909 \sin \omega$$

$$M = (.2123 \pm 1) + (14.96808 \pm 2)t + (.0003064 \pm 8)t^2 - (.96 \pm 5) \times 10^{-6}t^3 \\ + (.16 \pm 1) \times 10^{-6}t^4 - .0040105 \cos \omega$$

Standard error of one observation:  $\sigma = \pm 3^\circ 30$ .

The following elements are based on 64 observations and are valid for the period June 1 through June 15, 1963.

$$T_0 = 38188.0 \text{ MJD}$$

$$\omega = (153^\circ 62 \pm 5) + (1^\circ 595 \pm 8)t + .000494t^2 + 1^\circ 6490 \cos \omega$$

$$\Omega = (222^\circ 356 \pm 5) - (3^\circ 9617 \pm 9)t - .000110t^2 + .0205 \cos \omega$$

$$i = (57^\circ 625 \pm 2) - .0021 \sin \omega$$

$$e = (.04574 \pm 2) - .338 \times 10^{-4}t + .0012909 \sin \omega$$

$$M = (.8043 \pm 1) + (14.97741 \pm 2)t + (.0002821 \pm 7)t^2 - (.22 \pm 2) \times 10^{-5}t^3 \\ - (.56 \pm 21) \times 10^{-7}t^4 - .0040105 \cos \omega$$

Standard error of one observation:  $\sigma = \pm 2^\circ 00$ .

The following elements are based on 58 observations and are valid for the period June 15 through July 1, 1963.

$$T_0 = 38204.0 \text{ MJD}$$

$$\omega = (179^\circ 25 \pm 5) + (1^\circ 62 \pm 1)t + .000494t^2 + 1^\circ 6490 \cos \omega$$

$$\Omega = (158^\circ 932 \pm 4) - (3^\circ 9660 \pm 7)t - .000110t^2 + .0205 \cos \omega$$

$$i = (57^\circ 625 \pm 2) - .0021 \sin \omega$$

$$e = (.04528 \pm 3) - .338 \times 10^{-4}t + .0012909 \sin \omega$$

$$M = (.5053 \pm 1) + (14.98450 \pm 3)t + (.85 \pm 4) \times 10^{-4}t^2 - (.17 \pm 1) \times 10^{-4}t^3 \\ - (.75 \pm 6) \times 10^{-6}t^4 - .0040105 \cos \omega$$

Standard error of one observation:  $\sigma = \pm 2.05$ .

The following elements are based on 63 observations and are valid for the period July 1 through July 15, 1963.

$$T_0 = 38218.0 \text{ MJD}$$

$$\omega = (201^\circ 73 \pm 1) + (1^\circ 628 \pm 4)t + .000494t^2 + 1^\circ 6490 \cos \omega$$

$$\Omega = (103^\circ 390 \pm 1) - (3^\circ 9682 \pm 3)t - .000110t^2 + .0205 \cos \omega$$

$$i = (57^\circ 627 \pm 1) - .0021 \sin \omega$$

$$e = (.04499 \pm 1) - .338 \times 10^{-4}t + .0012909 \sin \omega$$

$$M = (.31808 \pm 3) + (14.98855 \pm 1)t + (.0001432 \pm 6)t^2 - (.114 \pm 5) \times 10^{-5}t^3 \\ - (.27 \pm 1) \times 10^{-6}t^4 - .0040105 \cos \omega$$

Standard error of one observation:  $\sigma = \pm 1.08$ .

The following elements are based on 52 observations and are valid for the period July 15 through August 1, 1963.

$$T_0 = 38234.0 \text{ MJD}$$

$$\omega = (227^\circ 61 \pm 2) + (1^\circ 619 \pm 4)t + .000494t^2 + 1^\circ 6490 \cos \omega$$

$$\Omega = (39^\circ 878 \pm 1) - (3^\circ 9709 \pm 4)t - .000110t^2 + .0205 \cos \omega$$

$$i = (57^\circ 628 \pm 2) - .0021 \sin \omega$$

$$e = (.04464 \pm 1) - .338 \times 10^{-4}t + .0012909 \sin \omega$$

$$M = (.16626 \pm 5) + (14.99257 \pm 1)t + (.0001378 \pm 2)t^2 + (.13 \pm 4) \times 10^{-6}t^3 \\ - .0040105 \cos \omega$$

Standard error of one observation:  $\sigma = \pm 1.98$ .

The following elements are based on 43 observations and are valid for the period August 1 through August 15, 1963.

$$T_0 = 38249.0 \text{ MJD}$$

$$\omega = (251^\circ 8 \pm 3) + (1^\circ 55 \pm 2)t + .000494t^2 + 1^\circ 6490 \cos \omega$$

$$\Omega = (340^\circ 292 \pm 9) - (3^\circ 974 \pm 1)t - .000110t^2 + .0205 \cos \omega$$

$$i = (57^\circ 624 \pm 9) - .0021 \sin \omega$$

$$e = (.0444 \pm 1) - .338 \times 10^{-4}t + .0012909 \sin \omega$$

$$M = (.0868 \pm 8) + (14.99704 \pm 7)t + (.0001341 \pm 6)t^2 - (.150 \pm 5) \times 10^{-5}t^3 \\ - (.73 \pm 14) \times 10^{-7}t^4 - .0040105 \cos \omega$$

Standard error of one observation:  $\sigma = \pm 1^\circ 68$ .

The following elements are based on 67 observations and are valid for the period August 15 through September 1, 1963.

$$T_0 = 38265.0 \text{ MJD}$$

$$\omega = (277^\circ 77 \pm 3) + (1^\circ 597 \pm 6)t + .000494t^2 + 1^\circ 6490 \cos \omega$$

$$\Omega = (276^\circ 696 \pm 3) - (3^\circ 9746 \pm 5)t - .000110t^2 + .0205 \cos \omega$$

$$i = (57^\circ 622 \pm 1) - .0021 \sin \omega$$

$$e = (.04453 \pm 1) - .338 \times 10^{-4}t + .0012909 \sin \omega$$

$$M = (.06692 \pm 8) + (15.00111 \pm 2)t + (.0001650 \pm 5)t^2 + (.70 \pm 3) \times 10^{-6}t^3 \\ - (.33 \pm 6) \times 10^{-7}t^4 - .0040105 \cos \omega$$

Standard error of one observation:  $\sigma = \pm 1^\circ 63$ .

The following elements are based on 38 observations and are valid for the period September 1 through September 15, 1963.

$$T_0 = 38280.0 \text{ MJD}$$

$$\omega = (301^\circ 91 \pm 4) + (1^\circ 606 \pm 9)t + .000494t^2 + 1^\circ 6490 \cos \omega$$

$$\Omega = (217^\circ 038 \pm 2) - (3^\circ 9805 \pm 8)t - .000110t^2 + .0205 \cos \omega$$

$$i = (57^\circ 621 \pm 3) - .0021 \sin \omega$$

$$e = (.04412 \pm 2) - .338 \times 10^{-4}t + .0012909 \sin \omega$$

$$M = (.1209 \pm 1) + (15.00612 \pm 2)t + (.000178 \pm 1)t^2 + (.195 \pm 8) \times 10^{-5}t^3 \\ + (.25 \pm 19) \times 10^{-7}t^4 - .0040105 \cos \omega$$

Standard error of one observation:  $\sigma = \pm 1^\circ 55$ .

The following elements are based on 68 observations and are valid for the period September 18 through October 1, 1963.

$$T_0 = 38298.0 \text{ MJD}$$

$$\omega = (331^\circ 5 \pm 2) + (1^\circ 56 \pm 3)t + 000494t^2 + 1^\circ 6490 \cos \omega$$

$$\Omega = (145^\circ 378 \pm 9) - (3^\circ 984 \pm 1)t - 000110t^2 + 0205 \cos \omega$$

$$i = (57^\circ 622 \pm 8) - 0021 \sin \omega$$

$$e = (.04413 \pm 4) - .338 \times 10^{-4}t + .0012909 \sin \omega$$

$$M = (.3060 \pm 5) + (15.0160 \pm 1)t + (.000276 \pm 1)t^2 - (.123 \pm 4) \times 10^{-4}t^3 \\ + (.43 \pm 5) \times 10^{-6}t^4 + (.142 \pm 9) \times 10^{-6}t^5 - .0040105 \cos \omega$$

Standard error of one observation:  $\sigma = \pm 2^\circ 38$ .

The following elements are based on 39 observations and are valid for the period October 1 through October 15, 1963.

$$T_0 = 38310.0 \text{ MJD}$$

$$\omega = (350^\circ 42 \pm 2) + (1^\circ 623 \pm 7)t + 000494t^2 + 1^\circ 6490 \cos \omega$$

$$\Omega = (97^\circ 544 \pm 2) - (3^\circ 9880 \pm 4)t - 000110t^2 + 0205 \cos \omega$$

$$i = (57^\circ 621 \pm 2) - 0021 \sin \omega$$

$$e = (.04389 \pm 2) - .338 \times 10^{-4}t + .0012909 \sin \omega$$

$$M = (.52739 \pm 5) + (15.02051 \pm 2)t + (.0002104 \pm 7)t^2 + (.587 \pm 5) \times 10^{-5}t^3 \\ + (.15 \pm 1) \times 10^{-6}t^4 - .0040105 \cos \omega$$

Standard error of one observation:  $\sigma = \pm 2^\circ 00$ .

## II. SAO mean elements -- Satellite 1963 9A

9 April - 30 July 1963

$\frac{T}{(MD)}$	$\omega$	$\Omega$	$i$	$e$	$M$	$n$	$n/2$	$q$	$N$	$D$	$\sigma$
381128.0	58.81 2	99.411 2	57.624 2	.04833 2	-31020 5	14.940311 2	-260E-3 1	6.627257	53 8	1.08	
381132.0	64.90 5	83.654 5	57.624 6	.04832 4	.0753 1	14.942380 4	.291E-3 2	6.626726	49 8	2.32	
381136.0	71.26 2	67.880 2	57.624 2	.04837 2	.84879 5	14.944783 2	-295E-3 1	6.625635	46 8	.73	
381140.0	77.35 2	52.096 3	57.620 3	.04824 3	.63255 7	14.947073 2	-287E-3 1	6.625888	32 8	1.18	
381144.0	83.6 1	36.324 9	57.630 9	.04820 7	.4250 3	14.94922 2	-250E-3 7	6.625514	20 8	3.25	
381148.0	89.92 8	20.535 7	57.619 7	.04813 5	.2254 2	14.951239 5	-266E-3 3	6.625431	26 8	2.92	
381152.0	95.83 6	4.753 6	57.626 6	.04803 5	.0354 2	14.953608 6	-327E-3 3	6.625386	34 8	2.61	
381156.0	102.14 7	348.959 8	57.627 7	.04778 6	.8547 2	14.956213 6	-334E-3 3	6.626358	32 8	2.96	
381160.0	108.43 3	333.154 2	57.624 2	.04769 2	.68469 7	14.959086 2	-386E-3 1	6.626133	35 8	.90	
381164.0	114.67 2	317.336 1	57.623 2	.04758 1	.52715 5	14.962127 2	-3554E-3 7	6.626025	68 8	.75	
381168.0	120.89 1	301.517 1	57.624 1	.047380 8	.38135 3	14.964903 9	-3446E-3 4	6.626594	66 8	.63	
381172.0	127.10 3	285.693 2	57.626 3	.04728 2	.24665 9	14.967572 2	-3088E-3 9	6.626488	48 8	1.41	
381176.0	133.41 3	269.864 2	57.627 3	.04702 1	.12174 7	14.970014 2	-3103E-3 8	6.627588	50 8	.95	
381180.0	139.63 2	254.030 2	57.626 2	.046815 7	.00699 4	14.972585 1	-3286E-3 5	6.628263	42 8	.51	
381184.0	145.86 3	238.190 3	57.625 3	.04655 2	.90272 9	14.975077 2	-295E-3 1	6.629354	36 8	1.07	
381188.0	152.13 3	222.343 3	57.623 3	.04639 2	.80790 7	14.977405 2	-292E-3 1	6.629827	46 8	1.03	
381192.0	158.55 1	206.4882 9	57.625 1	.046109 9	.72184 4	14.979565 1	-2398E-3 5	6.631115	83 8	.60	
381196.0	164.82 1	190.636 1	57.624 1	.04586 1	.64416 4	14.981408 1	-2219E-3 5	6.632280	102 8	.76	
38200.0	171.24 2	174.777 2	57.621 2	.04565 2	.57323 5	14.983207 2	-2258E-3 8	6.633222	67 8	.82	
38204.0	177.55 2	158.914 2	57.624 1	.04540 1	.50938 4	14.984548 2	-1419E-3 8	6.634580	55 8	.72	
38208.0	183.87 2	143.044 2	57.625 2	.04527 2	.45027 5	14.985792 2	-1604E-3 8	6.635108	40 8	.72	
38212.0	190.45 3	127.180 3	57.628 2	.04498 3	.39548 8	14.986946 2	-1305E-3 9	6.636790	35 8	.68	
38216.0	196.91 2	111.305 2	57.627 2	.04478 2	.34536 5	14.988016 2	-1420E-3 6	6.637884	34 8	.47	
38220.0	203.38 1	95.436 1	57.626 1	.04453 1	.29968 4	14.989105 1	-1244E-3 6	6.639292	37 8	.39	
38224.0	209.88 2	79.561 2	57.629 1	.04434 1	.25794 5	14.989973 1	-970E-4 5	6.640362	28 8	.31	
38228.0	216.47 2	63.681 2	57.629 2	.04419 2	.21929 6	14.990914 2	-1313E-3 7	6.641109	32 8	.71	
38232.0	223.12 2	47.803 1	57.629 2	.04397 1	.18468 5	14.991986 1	-1378E-3 4	6.642333	34 8	.61	
38236.0	229.64 4	31.920 5	57.632 7	.04378 4	.1549 1	14.993114 3	-1417E-3 9	6.643331	24 8	.99	
38240.0	236.28 4	16.034 3	57.626 6	.04360 4	.1293 1	14.994198 3	-139E-3 1	6.644228	17 8	1.15	

## II. SAO mean elements -- Satellite 1963 9A

3 August - 10 October 1963

T (MJD)	$\omega$	$\Omega$	i	e	M	n	$n^{1/2}$	q	N	D	$\sigma$
38244.0	242.84 4	.145 5	57.623 8	.04338 3	.1084 1	14.995349 2	-142E-3 1	6.645455	22 8	.76	
38248.0	249.8 2	344.254 4	57.624 5	.0435 1	.0908 5	14.996471 1	.1364E-3 5	6.643971	29 8	.50	
38252.0	256.5 4	328.36 1	57.63 1	.0434 2	.079 1	14.997493 3	.119E-3 1	6.644749	26 8	.90	
38256.0	262.4 8	312.45 4	57.62 2	.0431 3	.072 3	14.998328 3	.102E-3 2	6.646593	14 8	.82	
38260.0											
38264.0											
38268.0	282.76 3	264.781 2	57.622 2	.04313 2	.07134 8	15.001953 2	.1643E-3 8	6.645230	42 8	.80	
38272.0	289.57 2	248.874 1	57.627 1	.04309 1	.08145 6	15.003288 1	.1657E-3 6	6.645095	74 8	.65	
38276.0	296.24 3	232.966 2	57.624 2	.04304 2	.09735 8	15.004590 2	.1595E-3 6	6.645052	48 8	.67	
38280.0	302.78 6	217.05 1	57.63 1	.0431 3	.1188 1	15.005924 5	.172E-3 3	6.644263	16 8	.89	
38284.0	309.5 1	201.11 1	57.61 2	.0438 2	.1456 3	15.00747 1	.201E-3 3	6.645836	15 8	1.20	
38288.0											
38292.0											
38296.0	329.7 4	153.360 9	57.628 8	.04352 9	.272 1	15.014351 5	.343E-3 2	6.638832	53 8	.91	
38300.0	336.0 1	137.429 3	57.627 3	.04344 3	.3355 4	15.016545 3	.2460E-3 7	6.638762	61 8	.56	
38304.0	342.14 3	121.488 2	57.633 3	.04340 2	.40733 8	15.018211 4	.1724E-3 9	6.638522	42 8	.71	
38308.0	348.78 2	105.539 3	57.620 3	.04369 4	.48327 5	15.019507 5	.178E-3 2	6.636153	33 8	.94	
38312.0	355.44 3	89.593 4	57.629 5	.04356 3	.56490 9	15.021223 6	.257E-3 1	6.636566	31 8	1.19	

Table 11  
RELATIVE POSITIONS OF THE SUN AND THE PERIGEE OF SATELLITE 1963 9A

MJD	Z	$\Phi$	$\Psi$	D. R.A.	$\dot{P}$
PERIGEE IN EARTH SHADOW					
38128.	260.	46.3	107.0	123.9	-0.233E-05
PERIGEE IN SUNLIGHT					
38132.	261.	49.9	96.9	111.8	-0.261E-05
38136.	261.	53.1	88.5	101.1	-0.264E-05
38140.	262.	55.5	81.2	91.3	-0.257E-05
38144.	262.	57.1	75.2	82.7	-0.224E-05
38148.	262.	57.6	69.9	74.8	-0.238E-05
38152.	262.	57.2	64.2	66.1	-0.292E-05
38156.	263.	55.7	58.3	57.6	-0.299E-05
38160.	262.	53.2	51.3	47.9	-0.345E-05
38164.	260.	50.1	43.0	36.9	-0.318E-05
38168.	259.	46.4	33.6	24.6	-0.308E-05
38172.	258.	42.3	23.9	11.4	-0.276E-05
38176.	257.	37.8	16.9	357.3	-0.277E-05
38180.	256.	33.2	19.3	342.4	-0.293E-05
38184.	256.	28.3	30.3	327.0	-0.263E-05
38188.	255.	23.3	44.7	311.2	-0.260E-05
38192.	255.	18.0	60.5	295.1	-0.214E-05
38196.	255.	12.8	77.1	278.7	-0.198E-05
38200.	255.	7.4	94.1	262.3	-0.201E-05
PERIGEE IN EARTH SHADOW					
38204.	256.	2.1	111.3	245.6	-0.126E-05
38208.	257.	-3.3	128.6	229.0	-0.143E-05

Table 11 (cont.)

## RELATIVE POSITIONS OF THE SUN AND THE PERIGEE OF SATELLITE 1963 9A

MJD	Z	$\Phi$	$\Psi$	D. R.A.	$\dot{P}$
38212.	259.	-8.8	145.7	212.6	-0.116E-05
38216.	261.	-14.2	162.5	196.2	-0.126E-05
38220.	263.	-19.6	177.2	180.0	-0.111E-05
38224.	266.	-24.9	165.1	164.1	-0.863E-06
38228.	268.	-30.1	150.5	148.7	-0.117E-05
38232.	271.	-35.3	137.0	133.8	-0.123E-05
38236.	274.	-40.1	124.9	119.5	-0.126E-05
38240.	276.	-44.6	114.5	106.3	-0.124E-05
PERIGEE IN SUNLIGHT					
38244.	279.	-48.7	105.8	94.0	-0.126E-05
38248.	279.	-52.4	99.3	83.5	-0.121E-05
38252.	281.	-55.2	94.0	74.1	-0.106E-05
38256.	283.	-56.8	88.9	64.6	-0.907E-06
38268.	281.	-55.5	74.9	42.7	-0.146E-05
38272.	280.	-52.7	68.1	33.8	-0.147E-05
38276.	279.	-49.2	60.3	23.4	-0.142E-05
38280.	277.	-45.2	52.3	11.5	-0.153E-05
38284.	277.	-40.7	45.2	358.6	-0.178E-05
38296.	264.	-25.2	49.5	315.8	-0.304E-05
38300.	263.	-20.1	61.2	300.2	-0.218E-05
38304.	262.	-15.0	75.4	284.3	-0.153E-05
38308.	258.	-9.5	90.8	268.4	-0.158E-05
PERIGEE IN EARTH SHADOW					
38312.	258.	-3.9	107.0	252.4	-0.228E-05

## I. SAO smoothed elements

The following elements are based on 165 observations and are valid for the period May 7 through June 1, 1963.

$$T_0 = 38168.0 \text{ MJD}$$

$$\omega = (185^\circ 783 \pm 3) + (1^\circ 2177 \pm 4)t + .0466 \cos \omega$$

$$\Omega = (172^\circ 811 \pm 2) - (1^\circ 0531 \pm 3)t + .0196 \cos \omega$$

$$i = (42^\circ 744 \pm 1) + .00027t - .0117 \sin \omega$$

$$e = (.40048 \pm 1) + .821 \times 10^{-5}t + .0003971 \sin \omega$$

$$M = (.524763 \pm 4) + (6.3914343 \pm 7)t + (.15 \pm 4) \times 10^{-6}t^2$$

$$- .0001396 \cos \omega$$

Standard error of one observation:  $\sigma = \pm 1^\circ 00$ .

The following elements are based on 170 observations and are valid for the period June 1 through July 1, 1963.

$$T_0 = 38196.0 \text{ MJD}$$

$$\omega = (219^\circ 861 \pm 2) + (1^\circ 2168 \pm 2)t + .0466 \cos \omega$$

$$\Omega = (143^\circ 302 \pm 1) - (1^\circ 0539 \pm 1)t + .0196 \cos \omega$$

$$i = (42^\circ 7402 \pm 9) + .00027t - .0117 \sin \omega$$

$$e = (.400526 \pm 6) + .821 \times 10^{-5}t + .0003971 \sin \omega$$

$$M = (.485082 \pm 3) + (6.3914404 \pm 3)t - (.22 \pm 1) \times 10^{-6}t^2$$

$$- .0001396 \cos \omega$$

Standard error of one observation:  $\sigma = \pm 1^\circ 83$ .

The following elements are based on 129 observations and are valid for the period July 1 through August 1, 1963.

$$T_0 = 38226.0 \text{ MJD}$$

$$\omega = (256^\circ 343 \pm 4) + (1^\circ 2150 \pm 4)t + .0466 \cos \omega$$

$$\Omega = (111^\circ 686 \pm 3) - (1^\circ 0540 \pm 3)t + .0196 \cos \omega$$

$$i = (42^\circ 750 \pm 1) + .00027t - .0117 \sin \omega$$

$$e = (.40086 \pm 1) + .821 \times 10^{-5}t + .0003971 \sin \omega$$

$$M = (.228153 \pm 5) + (6.3914280 \pm 5)t - (.37 \pm 1) \times 10^{-6}t^2$$

$$- .0001396 \cos \omega$$

Standard error of one observation:  $\sigma = \pm 1.40$ .

The following elements are based on 189 observations and are valid for the period August 1 through September 1, 1963.

$$T_0 = 38256.0 \text{ MJD}$$

$$\omega = (292^\circ 833 \pm 3) + (1^\circ 2179 \pm 3)t + .0466 \cos \omega$$

$$\Omega = (80^\circ 041 \pm 2) - (1^\circ 0561 \pm 2)t + .0196 \cos \omega$$

$$i = (42^\circ 7530 \pm 7) + .00027t - .0117 \sin \omega$$

$$e = (.401195 \pm 5) + .821 \times 10^{-5}t + .0003971 \sin \omega$$

$$M = (.970649 \pm 4) + (6.3914053 \pm 4)t - (.319 \pm 8) \times 10^{-6}$$

$$- .0001396 \cos \omega$$

Standard error of one observation:  $\sigma = \pm 1.98$ .

The following elements are based on 245 observations and are valid for the period September 1 through October 1, 1963.

$$T_0 = 38288.0 \text{ MJD}$$

$$\omega = (331^\circ 798 \pm 3) + (1^\circ 2183 \pm 3)t + .0466 \cos \omega$$

$$\Omega = (46^\circ 253 \pm 1) - (1^\circ 0555 \pm 1)t + .0196 \cos \omega$$

$$i = (42^\circ 770 \pm 1) + .00027t - .0117 \sin \omega$$

$$e = (.401328 \pm 5) + .821 \times 10^{-5}t + .0003971 \sin \omega$$

$$M = (.495318 \pm 4) + (6.3913861 \pm 4)t - (.16 \pm 1) \times 10^{-6}t^2$$

$$- .0001396 \cos \omega$$

Standard error of one observation:  $\sigma = \pm 1.28$ .

T (MJD)	ω	Ω	i	e	M	n	n'/2	q	N	D	σ
38160.0	176.009 5	181.219 3	42.745 3	.40054 2	-393307 8	6.391433 1	.86E-5 7	7.352011	61 8	.42	
38164.0	180.873 5	177.007 4	42.742 2	.40049 2	.959141 8	6.391451 2	-.34E-5 10	7.352695	47 8	.36	
38168.0	185.729 4	172.793 3	42.745 2	.40043 1	.524911 5	6.391429 1	.34E-6 67	7.353433	55 8	.32	
38172.0	190.604 4	168.581 3	42.744 2	.40040 2	.090630 5	6.391443 1	.26E-5 6	7.353790	53 8	.36	
38176.0	195.475 4	164.367 3	42.743 2	.40037 2	.656414 5	6.391440 2	-.25E-5 8	7.354163	45 8	.34	
38180.0	200.346 4	160.148 3	42.748 2	.40037 2	.222142 1	6.391433 2	.7E-6 12	7.354159	34 8	.27	
38184.0	205.207 9	155.933 4	42.744 4	.40029 3	.787899 1	6.391441 2	.97E-6 86	7.355088	26 8	.50	
38188.0	210.097 5	151.714 2	42.738 2	.40022 2	.353651 6	6.3914464 7	.19E-6 28	7.356006	29 8	.30	
38192.0	214.956 4	147.501 2	42.743 2	.40026 1	.919433 4	6.391435 1	-.14E-5 8	7.355479	42 8	.27	
38196.0	219.833 3	143.286 2	42.746 2	.40024 1	.485145 4	6.391438 1	.14E-5 3	7.355688	59 8	.31	
38200.0	224.704 4	139.070 2	42.747 2	.400236 9	.050914 4	6.3914472 4	.58E-6 19	7.355774	69 8	.36	
38204.0	229.561 3	134.857 1	42.751 1	.400272 8	.616614 4	6.3914369 3	-.204E-5 14	7.355339	74 8	.33	
38208.0	234.433 3	130.645 1	42.755 1	.400312 9	.182415 3	6.391433 3	.12E-5 2	7.354857	67 8	.31	
38212.0	239.299 4	126.430 2	42.755 1	.40032 1	.748160 5	6.3914385 5	.65E-6 35	7.354716	43 8	.32	
38216.0	244.159 5	122.218 2	42.756 1	.40036 1	.313883 5	6.3914355 5	-.15E-5 2	7.354232	41 8	.33	
38220.0	249.037 4	118.002 2	42.758 1	.40042 1	.879627 5	6.3914250 4	-.91E-6 21	7.353517	42 8	.33	
38224.0	253.911 4	113.782 3	42.762 2	.40046 2	.445314 5	6.3914261 6	.34E-6 32	7.353023	35 8	.34	
38228.0	258.770 7	109.567 4	42.765 3	.40048 2	.011030 8	6.391427 1	.37E-6 56	7.352866	29 8	.46	
38232.0	263.634 8	105.355 5	42.763 3	.40056 2	.576728 9	6.3914196 6	-.11E-5 3	7.351798	28 8	.50	
38236.0	268.50 1	101.140 6	42.762 3	.40062 3	.14238 1	6.3914151 7	.16E-6 36	7.351056	23 8	.54	
38240.0	273.38 2	96.93 2	42.772 7	.40059 5	.70804 2	6.391420 1	-.55E-6 57	7.351482	17 8	.92	

$T$ (MJD)	$\omega$	$\Omega$	$i$	$e$	$M$	$n$	$n'/2$	$q$	$N$	$D$	$\sigma$	
38244.0	278.25	2	92.71	1	42.770	5	.40065	3	.27370	2	6.3914160	8
	283.10	2	88.51	1	42.752	6	.40082	4	.83934	2	.55E-6	42
38248.0	287.987	4	84.261	2	42.768	1	.40077	1	.391405	1	.21E-5	5
38252.0	292.859	3	80.046	2	42.763	1	.4008820	7	.970586	4	.3914078	3
38256.0	297.716	3	75.826	1	42.7634	9	.400900	7	.536219	4	.3914034	3
38260.0	302.594	3	71.602	1	42.7647	9	.400954	7	.101808	4	.3913957	3
38264.0	307.472	4	67.378	1	42.766	1	.400960	7	.667380	5	.3913971	3
38268.0	312.344	4	63.155	2	42.765	1	.400992	7	.232975	6	.3913983	4
38272.0	317.212	4	58.937	2	42.768	1	.401086	7	.798556	6	.3913908	5
38276.0	322.103	5	54.712	2	42.772	2	.401108	9	.364077	7	.3913893	7
38280.0	326.971	4	50.493	2	42.773	1	.401115	7	.929640	5	.3913928	6
38284.0	331.838	4	46.274	2	42.775	1	.401170	7	.495209	6	.3913871	5
38288.0	336.716	4	42.047	2	42.781	1	.401219	7	.060735	5	.3913804	5
38292.0	341.601	4	37.827	2	42.781	1	.401218	7	.626237	6	.3913830	5
38296.0	346.464	4	33.610	2	42.780	1	.401246	6	.191795	5	.3913857	4
38300.0												

Table 12

RELATIVE POSITIONS OF THE SUN AND THE PERIGEE OF SATELLITE 1963 13A

MJD	Z	$\phi$	$\psi$	D. R.A.	P
PERIGEE IN SUNLIGHT					
38160.	974.	2.7	50.2	311.1	-0.421E-06
38164.	974.	-0.6	55.9	306.6	0.166E-06
38168.	975.	-3.9	61.6	302.0	-0.166E-07
38172.	976.	-7.2	67.4	297.4	-0.127E-06
38176.	976.	-10.4	73.1	292.8	0.122E-06
38180.	977.	-13.7	78.8	288.2	-0.343E-07
38184.	978.	-16.8	84.2	283.8	-0.475E-07
38188.	980.	-19.9	89.4	279.4	-0.930E-08
38192.	980.	-22.9	94.3	275.2	0.685E-07
38196.	981.	-25.8	99.0	271.1	-0.685E-07
38200.	982.	-28.5	103.2	267.3	-0.284E-07
38204.	983.	-31.1	107.0	263.7	0.999E-07
38208.	983.	-33.5	110.3	260.3	-0.588E-07
38212.	984.	-35.7	113.2	257.2	-0.318E-07
38216.	984.	-37.7	115.6	254.4	0.734E-07
38220.	984.	-39.3	117.6	252.0	0.446E-07
38224.	984.	-40.7	119.1	249.8	-0.166E-07
PERIGEE IN EARTH SHADOW					
38228.	984.	-41.8	120.2	247.8	-0.181E-07
38232.	983.	-42.4	121.1	246.1	0.539E-07
38236.	983.	-42.7	121.7	244.5	-0.783E-08
38240.	983.	-42.7	122.3	243.0	0.269E-07

Table 12 (cont.)

## RELATIVE POSITIONS OF THE SUN AND THE PERIGEE OF SATELLITE 1963 13A

MJD	Z	$\varphi$	$\psi$	D. R.A.	$\dot{P}$
38244.	982.	-42.2	122.8	241.5	0.269E-07
38248.	980.	-41.4	123.4	239.8	0.103E-06
38252.	980.	-40.2	124.2	238.0	-0.348E-07
38256.	979.	-38.7	125.2	236.1	0.250E-07
38260.	977.	-36.9	126.6	233.8	0.279E-07
38264.	976.	-34.9	128.2	231.4	0.465E-07
38268.	975.	-32.6	130.1	228.6	-0.147E-07
38272.	974.	-30.1	132.5	225.7	0.152E-07
38276.	972.	-27.5	135.2	222.5	0.539E-07
38280.	970.	-24.7	138.2	219.1	-0.979E-08
38284.	970.	-21.7	141.5	215.5	-0.832E-08
38288.	968.	-18.7	145.2	211.8	0.685E-07
38292.	967.	-15.6	149.1	207.9	0.255E-07
38296.	966.	-12.4	153.2	203.9	-0.299E-07
38300.	966.	-9.1	157.5	199.8	0.436E-07

### I. SAO smoothed elements

The following elements are based on 182 observations and are valid for the period July 9 through August 1, 1963.

$$T_0 = 38230.0 \text{ MJD}$$

$$\omega = (207^\circ.83 \pm 2) + (3^\circ.514 \pm 2)t - .000603t^2 + .7130 \cos \omega$$

$$\Omega = (294^\circ.172 \pm 2) - (4^\circ.1675 \pm 2)t - .16 \times 10^{-4}t^2 + .0085 \cos \omega$$

$$i = (49^\circ.740 \pm 1) - .0023 \sin \omega$$

$$e = (.06137 \pm 2) + .1951 \times 10^{-4}t - .83 \times 10^{-7}t^2 + .0007662 \sin \omega$$

$$M = (.59218 \pm 5) + (14.099305 \pm 5)t + (.1740 \pm 7) \times 10^{-4}t^2 \\ - (.132 \pm 8) \times 10^{-6}t^3 - .0017968 \cos \omega$$

Standard error of one observation:  $\sigma = \pm 2^\circ.18$ .

The following elements are based on 213 observations and are valid for the period August 1 through September 1, 1963.

$$T_0 = 38256.0 \text{ MJD}$$

$$\omega = (298^\circ.95 \pm 1) + (3^\circ.512 \pm 2)t - .000603t^2 + .7130 \cos \omega$$

$$\Omega = (185^\circ.796 \pm 1) - (4^\circ.1683 \pm 1)t - .16 \times 10^{-4}t^2 + .0085 \cos \omega$$

$$i = (49^\circ.7360 \pm 9) - .0023 \sin \omega$$

$$e = (.06147 \pm 1) + .1520 \times 10^{-4}t - .83 \times 10^{-7}t^2 + .0007662 \sin \omega$$

$$M = (.18332 \pm 4) + (14.099900 \pm 7)t + (.1280 \pm 3) \times 10^{-4}t^2 + (.150 \pm 3) \\ \times 10^{-6}t^3 - .0017968 \cos \omega$$

Standard error of one observation:  $\sigma = \pm 2^\circ.15$ .

The following elements are based on 116 observations and are valid for the period September 1 through October 1, 1963.

$$T_0 = 38288.0 \text{ MJD}$$

$$\omega = (51^\circ 36 \pm 1) + (3^\circ 507 \pm 1)t - .000603t^2 + .7130 \cos \omega$$

$$\Omega = (52^\circ 392 \pm 2) - (4^\circ 1691 \pm 3)t - .16 \times 10^{-4}t^2 + .0085 \cos \omega$$

$$i = (49^\circ 741 \pm 1) - .0023 \sin \omega$$

$$e = (.06136 \pm 2) + .989 \times 10^{-5}t - .83 \times 10^{-7}t^2 + .0007662 \sin \omega$$

$$M = (.39310 \pm 3) + (14.100714 \pm 4)t + (.1813 \pm 5) \times 10^{-4}t^2 \\ + (.237 \pm 6) \times 10^{-6}t^3 - .0017968 \cos \omega$$

Standard error of one observation:  $\sigma = \pm 2^\circ 30.$

## II. SAO mean elements -- Satellite 1963 26A

14 July - 30 September 1963

T (JD)	$\omega$	$\Omega$	i	e	M	n	$n^{1/2}$	q	N	D	$\sigma$
38224.0	1886.23 2	319.176 4	49.744 5	.06132 2	.99820 6	14.098938 2	.165E-4 5	6.793775	49 8	.69	
38228.0	2000.2 3	302.512 7*	49.751 6	.0612 1	.3952 8	14.099075 1	.179E-4 7	6.794896	46 8	.62	
38232.0	214.16 3	285.821 5	49.736 3	.06098 2	.79265 8	14.099227 1	.193E-4 7	6.796147	58 8	.67	
38236.0	228.33 2	269.163 2	49.739 1	.06082 2	.19006 6	14.099367 2	.153E-4 6	6.797253	73 8	.69	
38240.0	242.60 2	252.492 2	49.740 1	.06072 2	.58764 5	14.099465 1	.113E-4 5	6.797948	84 8	.65	
38244.0	256.81 2	235.820 1	49.7384 9	.06066 1	.98572 6	14.0995775 7	.161E-4 4	6.798316	79 8	.52	
38248.0	270.89 2	219.143 2	49.740 1	.06065 1	.38466 5	14.0996820 9	.105E-4 4	6.798377	87 8	.63	
38252.0	285.15 2	202.470 2	49.741 1	.06142 1	.78328 5	14.099755 1	.91E-5 5	6.798107	70 8	.60	
38256.0	299.32 2	185.796 2	49.736 1	.06074 2	.18238 6	14.099849 1	.131E-4 5	6.797630	45 8	.58	
38260.0	313.56 3	169.126 3	49.737 1	.06088 3	.58167 7	14.099959 2	.138E-4 5	6.796621	41 8	.55	
38264.0	327.74 3	152.445 7	49.742 3	.06101 3	.9815 1	14.100087 1	.167E-4 7	6.795617	34 8	.51	
38268.0	341.07 3	135.779 8	49.739 5	.0611 2	.3826 8	14.100227 1	.173E-4 8	6.794687	32 8	.49	
38272.0	355.83 2	119.100 5	49.744 5	.06127 3	.78352 7	14.100339 2	.94E-5 8	6.793670	35 8	.60	
38276.0	9.88 1	102.426 2	49.744 2	.06147 2	.18497 4	14.100421 1	.129E-4 5	6.792216	40 8	.46	
38280.0	23.85 1	85.748 1	49.741 1	.06169 2	.58698 3	14.100542 2	.162E-4 7	6.790600	40 8	.51	
38284.0	37.80 1	69.069 2	49.738 2	.06182 3	.98942 4	14.100628 1	.88E-5 8	6.789578	28 8	.58	
38288.0	51.74 1	52.390 4	49.730 3	.06191 2	.39217 3	14.100735 3	.191E-4 9	6.788839	30 8	.46	
38292.0	65.56 1	35.712 5	49.735 3	.06204 2	.79583 3	14.100909 1	.187E-4 7	6.787881	32 8	.67	
38296.0	79.43 2	19.031 6	49.737 3	.06212 4	.19998 5	14.101113 3	.33E-4 1	6.787283	27 8	.83	
38300.0	93.22 2	2.360 7	49.736 2	.06219 4	.60513 6	14.101290 3	.20E-4 1	6.786742	23 8	.53	

Table 13

## RELATIVE POSITIONS OF THE SUN AND THE PERIGEE OF SATELLITE 1963 26A

MJD	Z	$\varphi$	$\psi$	D. R.A.	$\dot{P}$
PERIGEE IN SUNLIGHT					
38224.	416.	-4.8	40.1	30.7	-0.166E-06
38228.	418.	-15.3	41.1	19.3	-0.180E-06
38232.	422.	-25.4	46.6	8.9	-0.194E-06
38236.	426.	-34.8	54.4	0.6	-0.154E-06
38240.	429.	-42.6	61.5	355.2	-0.114E-06
38244.	432.	-48.0	66.0	353.5	-0.701E-04
38248.	432.	-49.7	66.6	354.3	-0.457E-04
38252.	431.	-47.4	63.1	355.1	-0.915E-07
38256.	429.	-41.7	56.4	352.9	-0.132E-06
38260.	425.	-33.6	48.2	347.3	-0.139E-06
38264.	421.	-24.0	41.3	339.0	-0.168E-06
38268.	418.	-13.9	39.4	328.7	-0.174E-06
38272.	415.	-3.2	43.8	317.8	-0.946E-07
38276.	414.	7.5	52.9	306.6	-0.130E-06
38280.	414.	18.0	63.6	295.8	-0.163E-06
38284.	416.	27.9	73.5	286.2	-0.885E-07
38288.	418.	36.8	81.2	278.7	-0.192E-06
38292.	420.	44.0	86.1	274.0	-0.188E-06
38296.	421.	48.6	88.3	272.7	-0.332E-06
38300.	421.	49.6	89.0	273.5	-0.201E-06

## NOTICE

This series of Special Reports was instituted under the supervision of Dr. F. L. Whipple, Director of the Astrophysical Observatory of the Smithsonian Institution, shortly after the launching of the first artificial earth satellite on October 4, 1957. Contributions come from the Staff of the Observatory. First issued to ensure the immediate dissemination of data for satellite tracking, the Reports have continued to provide a rapid distribution of catalogues of satellite observations, orbital information, and preliminary results of data analyses prior to formal publication in the appropriate journals.

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